FOREWARD

A basic policy of Alberta Agriculture is to maintain and expand Alberta's land base as one of the Provinces most important renewable resources.

Expansion of the land base for agriculture in a mature society such as exists in Alberta depends upon numerous factors including the land use potentials that exist from non-agricultural uses. This study was carried out to provide the Land Use Committee with basic economic information needs to examine the potential for agricultural expansion into areas where soil and climate capabilities are suitable for crop and livestock production.

In studying the report the reader should recognize that the economic analysis employed uses current economic cost and return data and that production levels reflect the technology currently employed in agriculture in the Peace River Area. Changes in commodity market prices, costs of inputs and technological or cultural developments would change the results considerably. The reader is also reminded that societal and individual considerations in addition to the economic perspectives provided in this study must be fully considered in arriving at land use decisions.

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TABLE OF CONTENTS

PAGE NUMBER

Foreword.....ii
Acknowledgements.....iii
List of Tables.....v
List of Figures.....vii
Executive Summary.....viii

1. INTRODUCTION 1

- 1.1 Objective of Study.....1
- 1.2 Scope.....2
- 1.3 Methodology.....2
- 1.4 Overview of Agriculture.....3
- 1.5 Overview of Forestry.....10

2. RELATIVE ECONOMIC IMPORTANCE OF FORESTRY AND AGRICULTURE.....16

- 2.1 National Level.....16
- 2.2 Provincial Level.....[illegible]

3. PHYSICAL DESCRIPTION OF STUDY AREA.....36

4. ANALYSIS OF COSTS AND BENEFITS 44

- 4.1 Current Forestry Use.....44
- 4.2 Agricultural Development.....49
- 4.3 Project Analysis.....78

5. SUMMARY AND CONCLUSIONS 97

- 5.1 Relative Importance of Forestry and Agriculture.....97
- 5.2 Forestry Potential in the Study Area.....98
- 5.3 Agricultural Potential in the Study Area.....101
- 5.4 Project Analysis.....105
- 5.5 Conclusions.....107

APPENDIX I MARKET CONDITIONS FOR AGRICULTURE AND FORESTRY.....110

APPENDIX II AGRICULTURE ON MARGINAL LANDS AND GREY WOODED SOILS.....131

LISTS OF REFERENCES.....155

LIST OF TABLES

TABLE #	DESCRIPTION	PAGE NUMBER
1	Census Data for Alberta, N.A.D.C. and Peace River Area, 1961-1976 (in acres)	8
2	Value of Products by industry, 1979 and 1980 ($ Billion)	17
3	Employment by Industry	19
4	Employment and Labour Force by Industry	20
5	Imports and Exports by Industry (1979 and 1980)	22
6	Gross Domestic Product by Industry at Factor Cost, Alberta 1971-1979 ($ Million)	25
7	Census Value Added in Goods-Producing Industries, Alberta 1971-1980 ($ Million)	26
8	Value of Production - Primary Industries 1971-1980 ($ Million)	28
9	Value of Production - Non-Primary Industries 1971-1980 ($ Million)	30
10	Employed Labour Force by Industry, Annual Averages, Alberta 1975-1980 (Thousands)	33
11	Summary of Forestry Statistics ($ Million)	35
12	Climatic Conditions	39
13	Estimated Costs and Returns for Logging and Sawmilling - Forestry Management Unit P4 (1981 - 1982)	48
14	Road Cost Estimates	51
15	Power Cost Estimates	53

LIST OF TABLES (cont'd)

TABLE #	DESCRIPTION	PAGE NUMBER
16	Soil Productivity Ratings	59
17	Yields of Major Crops	60
18	Costs and Returns on Class 2 Soils ($ Per Acre)	64
19	Weighted Average Costs and Returns ($ Per Acre)	64
20	Average Annual Returns Over Cash Costs and After Depreciation	77
21	Net Present Value Analysis Peace River Agriculture Project (250,000 Acres Phased in Over 3 Years)	81
22	Net Present Value Analysis Peace River Agriculture Project (250,000 Acres Phased in Over 5 Years)	83
23	Net Present Value Analysis Peace River Agriculture Project (250,000 Acres Phased in Over 10 Years)	85
24	Net Present Value Sensitivity Analysis (5 Percent Discount Rate)	89
25	Grain and Oilseed Prices, 1970/71 - 1980/81	113
26	Summary of Bulk Exports of Grain and Oilseeds, 1970/71 - 1980/81	118
27	Summary of Lumber Prices, Yearly Averages 1968 - 1982	124
28	Classification for Land Clearing Purposes, by Types of Tree Cover	138
29	Recommended Mixtures for the Grey Wooded Soil Zone	145

LIST OF FIGURES

FIGURE	DESCRIPTION	PAGE NUMBER
1	Location of Study Area	37
2	Proposed Cadotte, Peace River Agricultural Project Chart Showing Some Benefits and Costs	91
3	Grain and Oilseed Prices	111
4	Bulk Exports of Grain and Oilseed	119
5	Area of Principal Crops	121
6	Lumber Prices	125
7	Total Yield Produced by Four Wheat Crops Grown Successively after a Fallow-Wheat Rotation or Several Wheat Swards	143
8	Five Year Average Yields of Galt Barley Variously Fertilized, at Peace River Locations (1966 - 1970, c.w.t/acre)	148
9	Yields of Crops Grown on Two Very Acid Soils, With or Without Lime (2 Year Average, c.w.t./acre)	150

EXECUTIVE SUMMARY

The study was initiated at the request of the Land Use Committee, Alberta Agriculture. It forms part of the information base for use in the examination of possible areas for agricultural expansion in Northern Alberta.

The approach used was one of examining the current use of the study area for timber production, and its possible conversion to an agricultural use. The associated costs and returns of such a change were determined.

The first Chapter provides an introduction to the study and an overview of the two industries being examined. A brief historical review emphasises the role of agriculture and forestry in the development of Alberta. Changes in both the agricultural land base and the forestry land base during more recent times are reviewed.

In the second Chapter, a broader examination of the two industries is provided. The economic importance of agriculture and forestry is examined at the national level and the provincial level. Various measures of the economic contribution of each industry are provided.

A physical description of the study area is given in Chapter 3. Its location, climate, topography and drainage, vegetation, and soil, are briefly described. Access to the area and economic activities of the area are outlined.

In Chapter 4, costs and benefits related to agriculture and forestry are provided. Costs and returns for logging and sawmilling were estimated through interviews with companies operating in the area. Costs and returns for agriculture were developed through the use of both existing data and current informed estimates for specific items. Finally, project analysis is provided for agricultural development at the aggregate level.

Summary and conclusions are presented in Chapter 6. Both industries are export orientated and therefore world market conditions are of importance when considering changes in their production base. An examination of these conditions is presented in Appendix I. The concept of marginal land and an examination of research findings related to agriculture on Grey Wooded soils are reviewed in Appendix II.

Some of the major findings of the study are:

i) At the provincial level, agriculture contributed $1,751 million (5.4%) and forestry $44 million (0.1%) to Alberta's 1979 gross domestic product, at factor cost. Agriculture employed 83,000 and forestry 10,000. At the national level, the value of forest products shipped was $26.1 billion and total farm cash receipts $14.3 billion. Agriculture provided 693,500 jobs and forestry 304,000.

ii) Alberta's food and beverage industries contributed $3,241 million in value of shipments and provided 16,118 jobs. The wood products industries and paper and allied products industries contributed $776 million and employed 8,909 persons.

iii) Conversion of the study area from forestry use to agriculture would entail a cost of $53 million to provide roads and power, with access from the south via Three Creeks. Access across the Peace River by ferry would increase the cost by almost $1 million, while a bridge would cost $17 million. The cost per farm would be $106 thousand, $108 thousand and $140 thousand for each alternative respectively. Land clearing and tilling costs were estimated at $200 per acre or $50 million dollars for the entire project.

iv) Currently high production costs and restricted prices are producing minimal or negative returns. Losses of up to $26.00 per thousand board feet were estimated for the last timber year. Returns over cash costs of $21,700 and net returns after depreciation of $4,000 were determined for a 500 acre farm. Larger farms of 1,000 acres each would provide returns of twice this magnitude.

v) Project analysis for 250,000 acres based on 3 to 10 year phasing-in periods, produced the following results:

a) Net Present Value of 18.5 to 22.1 million dollars to farmers alone, and a net discounted cost of 34.8 to 40.5 million dollars to society, at a 5 percent discount rate. Negative values at higher discount rates.

b) Benefit-cost ratios of 1.34 to 1.36 to farmers and 0.42 to 0.46 to society, at a 5 percent discount rate. Ratios of less than 1.00 at higher discount rates.

c) An Internal Rate of Return of 8 to 9 percent for farmers and 1 percent to society.

d) A 15 percent reduction in the net cash inflow would reduce the net present value of the project to farmers to 8.0 to 9.7 million dollars. The discounted cost to the public would increase to levels of 48.8 to 57.0 million dollars.

e) Establishment of 250 1,000-acre farms instead of 500 500-acre farms would reduce the capital cost by 20.7 million dollars. This would reduce the discounted cost to the public to levels of 19.1 to 22.0 million dollars.

vi) On the basis of the results of partial economic analysis alone, this project would not be feasible. However, in making an investment decision, a number of other considerations must be taken into account. These include the loss of secondary benefits of the forest cover, the gain of induced or spin-off benefits from agricultural development, and the costs of providing services to the area and of maintaining infrastructure.

1. INTRODUCTION

The Alberta land base is a source of much conflict and debate among advocates of different land uses. There is conflict between urban development and agriculture, agriculture and forestry, single and multiple use of forest lands, agriculture and energy, forestry and energy, grazing and recreation, production and conservation, and so on. Beyond the actual physical use of land, is the question of the context in which land is used. Is land viewed as a resource to be exploited for maximum profit or one to be guarded and conserved, or a renewable resource to be carefully managed and utilized? Clearly, neither complete exploitation nor total conservation is desirable or realistic.

The availability of vast acreages of land to early settlers allowed, and may have encouraged, exploitation. Also, while populations were small and land appeared limitless, conflicts were not very significant. There appeared to be no constraint or "land budget" in which to work. As industrial growth intensified, the fact that land did have limits received greater recognition. Therefore, in the last two decades, land use planning has come to the forefront.

1.1 Objective of the Study

The purpose of this study is to compare the economics of converting a block of forested land to agricultural use as opposed to maintaining the forest in its current state. It is not the intent of this paper to present arguments for or against any particular land use, but it should be noted that a comparison of the economics of alternate uses cannot be completely divorced from the externalities associated with the different uses. Comparison of the former alternatives with that of developing the land for more intensive forestry management could form a separate study.

1.2 Scope

The initial study will examine the costs of maintaining the existing forests and the value of current timber production. The costs of developing the land for agricultural use, including clearing, breaking, seeding and provision of infrastructure (roads and power) and the potential benefits from such a project will be estimated. In the second phase the costs associated with a more intensive timber management project will be examined and the potential value of such a project estimated. The study will not examine the costs or benefits of other uses such as recreation or fish and wildlife, these could form the subject of a separate investigation.

1.3 Methodology

Although the study will be confined to a specific land base, the parameters used for estimating agricultural and forestry coefficients will be based largely on secondary data from comparable areas and conditions. Potential production for both agriculture and forestry will relate to existing Canadian Land Inventory classification data or other more current information available from Alberta Agriculture and the Timber Management Branch, Alberta Forestry.

Cost figures will be determined through an examination of estimates for similar activities and will be refined through the use of informed estimates from the relevant agencies involved in the industries concerned. These include the Alberta Forest Service, Public Lands and Resource Evaluation and Planning Divisions of the Department of Energy and Natural Resources and the Departments of Transportation, Environment and Agriculture.

This study is meant to be a very preliminary investigation and information collected and analysed would provide a better appreciation of the potential for agricultural expansion relative to forest development in the Peace River Region. The results will indicate whether a more detailed examination of the study area should be pursued. Some of the possible areas of study include a soil survey , an examination of marketing of agricultural products, and a study of the potential for more intensive forestry use.

1.4 Overview Of Agriculture

Historical Review

Settlement of western Canada was quite limited prior to the 1880's. Settlers were attracted to homestead land made available through the Homestead Act of 1870. The opening of the Canadian Pacific Railway (C.P.R.) line from Montreal and Vancouver, produced an inflow of settlers in the early 1900's. Settlement followed the branch lines and extended into the Peace River Region after 1912.

As early as 1779 Peter Pond established a fur trading post on the Athabasca River and was the first white man to cultivate land in Alberta, producing vegetables in his garden. Subsequent to this, missions were established and grains and vegetables grown to feed their isolated communities, barley and potatoes being the major crops grown. Wheat was not very successful in the early days because the late maturing varieties could not survive fall frosts. Wheat growing was recorded as early as 1825 at Fort Edmonton, but it was not until the 1870's with the introduction of Red Fife, that wheat became important in the west.

Meanwhile, ranchers came from the south, then the east, attracted to the open grasslands of the prairie left unused by buffalo. Between 1870 and 1900 the purely pastoral activities gave way to homesteading. Homesteaders began to encroach on the vast rangelands with the coming of the C.P.R. in 1883.

Cattle production thrived in the south and fur trading continued in the north, with farming activities associated with the missions. From 1883 to 1885 wheat was sown at Dunvegan then more successfully at Old Wife's Lake and Sharfsbury in 1886.

By 1905, when the province of Alberta was created, the total crop acreage was 416,000 acres. Around 40,000 homesteads had been granted between 1901 and 1905. The acreage cultivated increased rapidly to 3,668,238 by 1915 and the grain produced reached the level of 164,332,483 bushels.

The movement north into Athabasca and Smith followed a series of dry years and crop failures in the south and south-east. This was facilitated by an Order-in-Council in Ottawa in 1923 which provided one quarter section as a second homestead to settlers who had lost their original homesteads through drought.

Around the 1930's the high quality of seed grain from the northern part of the province was becoming recognized, and the demand from outside was increasing. A number of awards and championships were won by farmers producing wheat and oats, peas, timothy and brome in the Peace River area. The early attempts with wheat (1870's) were in the low-lying river valleys, and it was some time before it was generally believed that wheat might be grown on the plains above.

Lands in central and southern Alberta were pretty much occupied, at least as far as good homestead land was concerned, and the trend of immigration was to the north. Early settlers went in by the Athabasca, Lesser Slave Lake and Peace River Trail or followed the Grande Prairie Trail north of Edson. The population in Peace country grew from

2,000 in 1911, to 60,000 in 1930. The major impetus for movement in was the opening of the Edmonton, Dunvegan and British Columbia Railway to the south Peace River country in 1916.

Even during the war years settlement continued, and although immigration from overseas was cut off, settlers arrived from the United States and eastern Canada. Two land agencies of Peace River and Grande Prairie accounted for 45.1 percent of all homestead entries on Dominion lands in western Canada in 1928.

The homestead policy had proved valuable in populating the west, but it had been a matter of survival of the fittest and many did not succeed. When in 1930 the province's natural resources were turned over from the Dominion to the province, better land use became an issue. Thought was given to an agricultural land policy through which unplanned settlement of the past would be avoided.

In 1939 homestead entries were discontinued and replaced by an agricultural lease policy. Under the new arrangement the land was inspected by the Department of Lands and Mines before settlement, to make sure that the soil and topography were satisfactory and that at least 50 percent of the area was suitable for cultivation. The inspector also reported on the amount and cost of clearing to be done, distances from schools, condition of roads and other factors that might have a bearing on the success of settlement. Leases were granted for twenty years and renewable for a further twenty years, with an option to purchase after the first ten years of the lease, providing the terms of the lease had been fulfilled.

Scattered and indiscriminate settlement was avoided by land being opened up by areas and only the good land in those areas being made available for settlement. By this time the available land was chiefly in wooded areas, but as late as the 1960's there was a rush for land in such areas as that of the Peace River region. Settlement of the north became less risky as improved methods of breaking and clearing the land were devised, new and better varieties developed and soil management techniques improved. A lot of this knowledge resulted from studies at the research centres of Beaverlodge and Fort Vermillion.

Homesteading was not easy and settlers without money had to seek outside sources of income to finance land breaking and clearing and provide cash for the homestead. In those pioneer days homesteaders earned money by working for other homesteaders who were better off, they also worked on survey teams, in railway construction and freighting, and with Dominion Government Departments, Land Offices and retail stores. Some worked at mining camps, or cut and sold firewood and railway ties, repaired and resold old farm implements or raised oxen and horses for sale.

As early as 1905 close to 1,000 head of cattle and a similar number of horses were reported for the Fort Vermilion, Peace River Crossing, Spirit River and Grande Prairie areas. However, grain was the major interest and mills were soon established in each of these areas.

Some of the characteristics of early Northern development persist to the present time. Farming in the Peace River Region is still closely dependent on income from off the farm, land clearing and breaking is a slow costly process and the pattern of expansion is dictated by access in the form of railways and roads. Livestock is still not a major enterprise. The number of frost-free days is a major determining factor in the crop mix adopted and specifically the proportion of wheat which can be managed by an individual farmer.

Agricultural Land Base

Through the years many changes have occurred in Alberta's agriculture, including changes in total farm area, farm population, number of farms, average farm size, technology and market conditions.

Additions and deletions make up an important component in the value of Alberta's agricultural land base. In 1976 the agricultural land base totalled 49.9 million acres, from 1976 to 1980, 386.7 thousand acres were added and 390.1 thousand acres removed from the agricultural land base. Therefore, total farm area had a fairly insignificant net loss of 3.4 thousand acres. However, 1976 to 1980 saw a net loss of 90.9 thousand acres of agricultural land in C.L.I. Class 1 to 3 and a net gain of 85.0 thousand acres in C.L.I. Classes 4 to 6 and organic. These acreages, although small in relation to the total agricultural land base, can have large effects on choice of crops, yields, farm production costs and profitability. Removal of agricultural land in Classes 1 to 3 was due largely to urban annexations. To partly offset this loss cultivation has expanded into new lands in the Peace River area, with C.L.I. Classes 4 to 6 and organic being the dominant classes developed.

The majority of additions to the agricultural land base came from the disposition of public lands (i.e. farm development sales, grazing permits, cultivation leases, etc.). To a much lesser extent abandoned oil and gas wells and reclaimed strip mines were also involved in additions. Removal of agricultural land came from a number of different sources. These included: (1) non-agricultural subdivisions such as country residences, commercial, farmstead separations, etc., (2) urban annexations, (3) roads, (4) oil and gas wells, (5) gas plants, (6) coal strip mines, and (7) public land reservations, (Resource Economics, 1982).

Periods before 1976 saw an increase in total farm area. From 1971 to 1976 there was an increase of only 0.85% and 1961 to 1976 saw an increase of 5.7% (Table 1). In the Northern Alberta Development Council (N.A.D.C.) area total farmland has increased substantially; there was a 36% increase between 1961 and 1976 and a 5.0% increase between 1971 and 1976. This is the result of large amounts of new farmland being opened up

TABLE 1
CENSUS DATA FOR ALBERTA, N.A.D.C.(1) AND PEACE RIVER AREA(2)
1961 - 1976 (in acres)

Region	Farm Population	% of Total Population	Number of Farms	Average Size of Farms	Total Farm Area
Alberta					
1961	287,814	21.6	73,212	645	47,229,000
1966	281,583	19.2	69,411	706	48,983,000
1971	237,924	14.6	62,702	790	49,506,000
1976	219,302	11.9	61,130	817	49,929,000
1971-76 % diff.	-7.8%	-	-2.5%	+3.4%	+.85%
1961-76 % diff.	-23.8	-	-16.5%	+26.7%	+5.7%
N.A.D.C.					
1961	53,000	4.0	14,200	n.a.	6,500,000
1966	55,000	3.8	13,800	n.a.	7,200,000
1971	46,000	2.8	12,613	667	8,413,053
1976	36,498	2.0	11,808	749	8,835,621
1971-76 % diff.	-20.6%	-	-6.4%	+12.3%	+5.0%
1961-76 % diff.	-31.1%	-	16.8%	-	+36%
Peace River					
1961	n.a.				
1966	n.a.				
1971	n.a.	n.a.	8,398	688	5,779,671
1976	24,516	1.3	8,120	757	6,147,912
1971-76 % diff.	-	-	-3.3%	+10.0	+6.4%

(1) Northern Alberta Development Council Area - Approximate numbers only in most cases.

(2) Includes ID's 16, 17, 19, 20, 21, 22, 23, 136; MD's 130, 133, 135 and County 1.

Source: - Alberta Agriculture Agriculture Statistics Yearbook, 1980.
- Northern Alberta Development Council Trends in Northern Alberta: A Statistical Overview, 1971 - 1979. Agriculture in Northern Alberta, Discussion Paper, September, 1978.
- Alberta Census of Agriculture. I.D., M.D. and County data by region 1971, and 1976.

in Northern Alberta, particularly in the Peace River area (Environment Council of Alberta, 1981). In the Peace area alone total farm area increased 6.4% between 1971 and 1976.

While the trend from 1961 to 1976 was towards an increase in total farm area, the opposite occurred in the farm population for that time period. There was a substantial decrease of 23.8%. As a result the number of farms also decreased 16.5% over this period with 1981 census data showing a continued decrease. As the farm population and number of farms decreased, and total farm area increased the result was an increase in the average farm size. Over this 15 year period average farm size increased by a substantial 26.7%.

The above results show that over the years, even though farms became larger, there was a shift of population off the land. In 1931 the farm population made up over half the total population of Alberta, and with agriculture bringing in the greatest revenue the provincial economy was structured around it. Since 1931 Alberta's mineral development has boomed. As a result there has been a major shift in the structure of the provincial economy and with this shift people began moving from rural to urban areas. In 1951 the farm population numbered 36.7% of the total provincial population. Data in Table 1 show that this percentage has declined to 21.6% in 1961 and further declined to 11.9% in 1976.

Technological Changes

As the provincial economy shifted towards mineral development and farm population decreased, agriculture remained important due to technological changes. Advances in technology allowed for total farm area and average farm size to increase; it also facilitated an accelerated decrease in the farm population and an expansion in the range of farm products (Environment Council of Alberta 1981). Technology of the 1930's limited the extent of clearing of new farmland due to the tedious nature of the operation, today modern equipment is being used to clear thousands of acres in the Peace area. Many farm workers were needed to work a quarter section of land in the 1930's; this had a definite effect on the size of farms. Today, due to mechanization and technical innovations which allow very little labour input into the land, one farmer can work several quarter sections.

In 1961, 1.0% of all farms ranged in size from 2,240 - 2,879 acres. This size category increased to 1.7%, 2.0% and 2.1% in 1971, 1976, and 1981 respectively. This same trend can be seen in farms 2,880 acres and over in size. In 1961 2.0% of all farms were this size; 1971, 1976 and 1981 saw increases to 3.0%, 3.5%, and 3.6% respectively (Alberta Agriculture, 1981 Yearbook).

Since World War II, increased use of fuel, machinery, fertilizers and pesticides increased average yields per acre and promoted greater yields per unit of input. Plant genetics and greater knowledge in soil and crop management have also played significant roles in the increase of agricultural productivity. These changes in technology and an increase in average farm size have allowed farmers to become highly efficient food growers, moving from a labour-intensive operation to a captial-intensive operation.

1.5 Overview of Forestry

Historical Review

During the years 1670 to 1870, northern Alberta, then part of Rupert's Land, was under the administration of the Hudson's Bay Company. By charter of May, 1670, the Hudson's Bay Company was given absolute territorial rights to trade, colonize and govern all the land drained by the waters that flow into the Hudson Bay and Hudson Straits. From the

1700's and 1800's there were conflicts between alternate uses of the land, specifically between trade and settlement. The Company's major interest was the fur trade and colonization was discouraged (Morton, 1938).

The British North America Act was passed in 1867 and the Confederation of Canada declared. After 200 years of control the Hudson's Bay Company surrendered its charter to the Queen, and the North West Territory and Rupert's Land were officially transferred to the Dominion of Canada by Order-in-Council of 1870 (Galbraith, 1957). The Canadian Government administered the lands for the purposes of settlement and construction of a transcontinental railway (Morton, 1938); timber was not viewed as a revenue earner.

The railway was completed within 15 years, but federal administration of public lands continued for another 45 years. This was considered important to facilitate land settlement. Control of the natural resources was not transferred to the provincial government until 1930. National fisheries remained subject to federal constraints (Alberta Forest Service 1967).

Early settlers were entitled to the surface rights of the soil including timber and were permitted to cut specified quantities of wood from unoccupied Dominion lands free of charge (where the wood resource was lacking on their own lands). Additional quantities were available at a fee.

Licences to cut timber on Dominion lands were first introduced by legislation in 1879, by the Dominion Lands Act, cutting rights were granted by tender or public auction. This system was revised in 1889, licences were sold by public auction and renewable annually, subject to payment of rental and dues. In 1903, by Order-in-Council, licence renewal was made subject to the existence of merchantable timber and the licencee's compliance with the regulations.

More emphasis was placed on forest management when, in 1898, the Dominion Forest Service was formed, with provisions for making regulations. However, management was subject to constraints. Large areas of accessible merchantable timber (licenced timber berths) were managed by the Timber and Grazing Branch. These areas fell within the forest reserve but were exempt from reserve regulations. Routine administration was the concern of the Timber and Grazing Branch while fire patrol was the responsibility of the Forestry and Parks Branches. Lumbermen were allowed to range almost indefinitely over berths as long as merchantable timber was available. There were no adequate safeguards for reforestation (Morton, 1938). So, while the existence of portable saw-mills was almost essential to settlement, large areas of forests were threatened with being denuded by their existence.

Dominion policy was aimed at supplying timber for settlement not for revenue. Thus the potential of the timber inventory as a source of capital for reforestation was not fully tapped. During the period of Dominion land, federal expenditure on forest conservation was approximately $18,200,000, while revenues from forest reserves approximated $16,300,000 (Morton, 1938). It was during this time however, that the concept of sustained yield management evolved.

This type of management strives to ensure that resources will be utilized in a rational manner, without undue waste. Legislative authority to manage the timber resources of Alberta is provided by the Forests Act, 1971, the Forest Protection Regulations, effective April 19, 1962 and the Forest Management Regulations, effective May 1, 1966. The Alberta Forest Service has the responsibility for enforcing the terms of the Act and the Regulations. The basic function of the Alberta Forest Service is to help perpetuate the proper uses of the resources of the forested area of Alberta (Alberta Forest Service, 1967).

Forestry Land Base

The surface area of Alberta is 255,285 square miles of which approximately 156,000 square miles is forest land. National parks occupy 15% of the forest lands and water bodies 3%. The net area available for forestry use is 128,000 square miles. An undetermined acreage is also set aside exclusively for Provincial Parks, wilderness areas, wildlife sanctuaries, and other non-timber production related use (Canadian Institute of Forestry, 1982).

The forested area, or Green Area, was designated by Order-In-Council 113/48 of 1948 and a boundary was established separating the forested area from the settlement area. The lands within the Green Area were to be managed for mulitple use, including timber, water production, fish and wildlife, industrial development and grazing. Agricultural development other than grazing was to be excluded.

The boundary between the Green Area and settlement area has shifted over the years. These shifts reflect demands for land for other purposes, notably agriculture. Over the six year period 1975 to 1981, although the Green Area acreage has fluctuated with shifts in the boundary, there has been a net increase of almost 50,000 acres (49,796) or 77.77 square miles. However, it is argued that the shifting of the boundary precludes long-term (60-80 years) financial investment in timber production along the boundary (Canadian Institute of Forestry, 1982).

As is the case with the agricultural land base, disturbances including temporary and permanent losses of forested land, are associated with oil, gas and coal recovery. There is an annual average energy-related disturbance of 27,000 acres of forested land. Many of these disturbances are not permanent but are considered long-term because of probable reuse by the energy industry. Another 3,000 acres of productive forest land is being annually removed for recreational and related uses.

Public land dispositions represent another reduction of the productive or potentially productive forested area. During the period 1976 - 1980 public land dispositions amounted to 371,000 acres or an average of 74,200 acres per year. Disposition categories are civilian homestead sales, public land sales for agricultural use, farm development leases, grazing permits, cultivation permits, forest grazing leases and grazing reserves. Provided certain conditions are met, sales of public lands lead to transfer of legal title, while leases and permits do not lead to legal title. Grazing reserves remain under the control of the Public Lands Division and are developed as community pastures. It is estimated that, over the long term, about 60% of land in grazing reserves is eventually developed for improved grazing (Alberta Agriculture, 1982).

Sales represent approximately half of all land dispositions. However, it is difficult to accurately distinguish between agricultural and non-agricultural land sales. In the various categories of disposition the permitted agricultural uses range from grazing as part of multiple use management to cultivation. Land improvements range from little or no change to clearing, breaking and cultivation.

On a national basis Alberta's forest industry is modest when compared with the major forest producing provinces of Ontario, British Columbia and Quebec. However Alberta is one of the few provinces with a surplus of merchantable fibre resource. Only one percent of the deciduous annual allowable cut (A.A.C.) is being utilized. Approximately 60% of the coniferous A.A.C. is committed, of which 80% is currently being harvested. Foresters are concerned about protecting this "final reserve" and not permitting the kind of misuse leading to partial depletion that is occurring in other provinces.

This concern is emphasized by an estimate presented by Reed and Associates (1980) on recent reductions in the Canadian timber base. The principal finding was that sustainable harvest levels were reduced by as much as 22 percent over the figures confidently predicted in the 1970's.

Annual allowable cut figures have been revised downward and quite a number of timber limits are seriously over committed. The reasons for this reduction include a failure to assist nature in regenerating a new timber crop on harvested lands, and the steady reduction in the timber available for industrial use through changes in the allocation of forest land and through losses by fire and insects.

2. RELATIVE ECONOMIC IMPORTANCE OF FORESTRY AND AGRICULTURE

2.1 National Level

At the national level forested lands occupy one third of the land area (3.26 million km^2). The total area of the ten provinces is 5.4 million km^2 of which 2.9 million are forest lands and 400,000 km^2 are improved farm lands. Primary forest products were estimated at 165 million m^3 or 115 million metric tons compared with 40 million tons of grain, 25 million tons of hay, 5 million tons of other principle field crops, 91 million tons of iron ore, coal, zinc and copper and 1 million tons of fish for 1979 (Reed 1979).

Comparison of volumes alone is not very meaningful as an economic measure but it does indicate the relative multiplier effects of the various industries in terms of the handling and transportation sectors. Of more importance are the relative values of these products. Reed's estimates of sales value for 1979 were $17 billion for manufactured forest products, $4 billion combined farm cash receipts for grains and $1 billion for all processed fishery products.

Statistics Canada (1979 and 1981) data, summarized in Table 2, indicate that the value of forest products shipped in 1979 amounted to $26.1 billion, total farm cash receipts were $14.3 billion and the value of fish products was $1.5 billion. These figures are significantly higher than the Reed estimates and the relative proportion by sector are also quite different. However, the picture obtained from both estimates is that of the three sectors discussed, forestry has the highest value of product shipped. The figures are somewhat biased against agriculture since farm cash receipts reflect the value of unprocessed farm products whereas the values for the forestry and fishery sectors are those for processed products.

TABLE 2

VALUE OF PRODUCTS BY INDUSTRY

1979 and 1980

($ Billions)

	1979	1980
Forest Products	26.11	
Farm Cash Receipts	14.26	15.62
Fishery Products	1.50	
Fuels	14.62	18.48
Primary Metal	9.87	11.00
Non-Metalics and Structural Materials	3.50	4.19

Source: Statistics Canada - Canadian Statistical Review. Dec., 1981.
Bulletin no. 11 - 003E.

Statistics Canada - Canadian Forestry Statistics, 1979.
Bulletin no. 25 - 202.

Statistics Canada - Fish Products Industry, 1980.
Bulletin no. 32 - 216.

Alberta Statistical Review Annual 1980 - Alberta
Bureau of Statistics, 1981.

In terms of employment, Reed (1980) presented estimates for the four sectors (Table 3) which ranked forestry second to agriculture. The total for agriculture for 1979 was 693,500, forestry 304,000, mining 234,200, and fishing 68,300. At the primary level, agriculture provided employment for 478,000 or 37% of all jobs of the four resource industries; while forestry (logging) provided 54,000 jobs or 4%. At the processing level forestry provided 250,000 jobs compared with 215,500 for agriculture, representing 16% and 15% of all jobs in the four sectors respectively.

Reed's figures were derived from the Labour Force Survey annual averages plus supplementary information, not specified. Statistics Canada (1979) forestry employment figures total 307,580 of which 56,614 were employed in logging. Reed contends that the actual number involved in logging was closer to 76,000 including small contractors, woodlot owners, reforestation workers and others not included in the census of manufacturers.

Another source of employment data is the Statistics Canada Labour Force (1979) bulletin (given in Table 4). Agriculture is again ranked highest at 442,000 employed, of which 112,000 are paid workers. Mines, quarries and oil wells ranked second at 175,000 employed of which 173,000 are paid workers. Forestry employed 81,000 of which 74,000 were paid workers and fishing and trapping 25,000 of which 9,000 were paid workers. The total labour force was 7% higher than the actual numbers employed, 95% of the labour force reported for both agriculture and mines, quarries and oil wells were employed, compared with 83% and 72% for forestry and fishing and trapping respectively.

Reed (1980) argued that the composition of the primary agriculture data (478,000 employees) posed a problem of comparability since over half of this number were owners and employers, and less than one third were actually paid workers; the balance (19%) being unpaid family workers. In another paper Reed (1979) stated that there were 300,000 farms in Canada and that the owners of these farms traditionally

TABLE 3

EMPLOYMENT BY INDUSTRY

	1979 Total	Primary	Processing
Forestry	304,000	54,000	250,000
Agriculture	693,500	478,000	215,500
Fishing	68,300	42,700	25,600
Mining	234.200	115,900	118,300

Source: Reed, F.L.C. & Associates Ltd. Regional Employment Generation by the Forest Sector in 1979 for the Canadian Forest Congress, Toronto, 1980.

TABLE 4

EMPLOYMENT & LABOUR FORCE BY INDUSTRY

	Employment		Labour Force	
	All Classes of Workers	Paid Workers	All Classes of Workers	Paid Workers
Forestry	81	74	95	87
Agriculture	442	112	465	134
Fishing & Trapping	25	9	32	14
Mines, Quarries & Oil Wells	175	173	183	181

Source: Statistics Canada. The Labour Force. December 1979 - Feature: 1979 Annual Bulletin #71 - 001.

forego regular wages. These statements seem to imply that the employment generation value of agriculture is overestimated, a point which is debatable. In other discussions of farm income, farmers foregoing wages are said to be either living off of depreciation or deferring income to the time of retirement or farm sale. In whatever way farming is viewed, it cannot be disputed that farming provides employment for these 300,000 farmers whether they derive a regular cash income or not.

Returning to the value of sales it is important to examine the relative contributions of each sector to international trade (Table 5). Total forest exports rose from $11.22 billion in 1979 to $12.09 billion in 1980 compared with $4.66 and $6.59 billion for the farm, food and beverage sector in the same years (Statistics Canada, 1981). Fishery exports fell slightly from $1.29 to $1.24 billion while coal, petroleum and gas exports increased from $5.29 to $6.88 billion. The combined export values for ores and concentrates, iron, steel and non-ferrous metals and for chemicals and fertilizers increased from $11.82 to $15.60 billion over 1979 to 1980. The highest values relate to the export of machinery and equipment, including auto pact. 1979 exports were at $29.25 billion and 1980 exports at $42.39 billion.

Of perhaps more significance is the net impact on the trade balance. This involves an examination of imports of the various products and the net contribution of each sector to the balance of trade. Imports of fish products and forestry products have little or no impact on the trade balance, being zero for fisheries and only $0.36 and $0.39 billion for forestry in 1979 and 1980. Thus exports from these sectors make a combined contribution equal to, or almost equal to total exports. On the other hand, imports in the other sectors amounted to $2.68 and $2.98 billion for farm, food and beverages (1979 and 1980), $5.50 and $8.04 billion for coal, petroleum and gas and $6.49 and $7.46 billion for ores and concentrates, iron, steel and non-ferrous metals and chemicals and fertilizers. Again, the largest single import values are associated with machinery and equipment, decreasing from $68.09 billion in 1979 to $66.85 billion in 1980.

TABLE 5

IMPORTS & EXPORTS BY INDUSTRY

(1979 and 1980)

	1979			1980		
	EXPORT	IMPORT	BALANCE	EXPORT	IMPORT	BALANCE
			($'000,000,000)			
Forest products	11.2	0.36	10.86	12.09	0.39	11.70
Farm, food, beverage	4.66	2.68	1.98	6.59	2.98	3.61
Fisheries	1.29	-.--	1.29	1.24	-.-	1.24
Coal, Petroleum, gas	5.29	5.50	(0.21)	6.88	8.04	(1.16)
Ores, concentrates	3.89	0.58	3.31	4.21	0.71	3.50
Iron, steel non-ferrous metals	5.25	4.66	0.59	8.11	5.48	2.63
Chemicals, fertilizers	2.68	1.25	1.43	3.28	1.27	2.01
Total - ores, metals chemicals	11.82	6.49	5.33	15.60	7.46	8.14
Machinery & equipment including auto pact	29.25	68.09	(38.84)	42.39	66.85	(24.46)

Source: Statistics Canada. Canadian Statistical Review.
Bulletin # 11 - 003E.

The result is that forestry makes the highest net contribution to the balance of trade, contributing $10.86 billion in 1979 and $11.70 billion in 1980. Exports from the food sectors rose faster than imports and thus the net contribution rose from $1.98 to $3.61 billion. Fisheries contributions equaled exports, falling from $1.29 to $1.24 billion. Energy imports increased at a faster rate than exports and the net deficit increased from $0.21 to $1.16 billion. The combined contribution from ores, metals and chemicals rose from $5.33 to $8.14 reflecting a $2.04 billion increase in exports of metals and $0.58 billion for chemicals. Finally the largest deficits were recorded for machinery and equipment, amounting to $38.84 billion in 1979 and $24.46 billion in 1980.

2.2 Provincial Level

At the provincial level, while forest lands occupy 388,000 km^2 and improved farm land 112,000 km^2, Alberta's agriculture sector is of greater significance economically. Up to the early 1970's farm cash receipts accounted for 20% of the net dollar value of goods produced and agricultural production employed 86,000 Albertans or 12% of the total provincial labour force. The highest dollar earner was mining, accounting for 42% of the net value of production but employing only 26,000 workers or 4% of the labour force (Alberta Agriculture).

The Agricultural Economics Research Council of Canada (1972) estimated that in the late 1960's 65% of Alberta's economic activity was agriculture related. This compared with Ontario at 41%, British Columbia at 22%, Saskatchewan at 85% and the whole of Canada at 42%. This influence of agriculture is brought about through linkages with transportation, processing and storage of agricultural goods, sale of machinery, fertilizers and chemicals, and services to the agriculture sectors as well as less direct linkages such as food outlets.

Since the early 1970's the economy has shifted drastically towards the petroleum industry and agriculture's importance has been somewhat overshadowed (Table 6). Alberta's gross domestic product (G.D.P.), at factor cost, for agriculture rose from $459 million in 1971 to $1,751 million in 1980 compared with $1,183 and $7,942 million for mining, representing increases of 280% and 570% respectively (Alberta Statistical Review Annual, 1980). In terms of percentages, agriculture's contribution to Alberta's G.D.P. fell from 6.2 percent to 5.4 percent, while mining's contribution rose from 16.1 percent to 24.4 percent over the period 1971 to 1980.

The net dollar value (census value added) for agriculture rose from 441 million dollars (12%) to 1,703 million (6%) and that for mines from 1,486 million (40%) to a high of 15,464 million (55%) (Table 7). These net values include the value of goods and services produced,

TABLE 6

GROSS DOMESTIC PRODUCT BY INDUSTRY AT FACTOR COST (1)

ALBERTA
1971 - 1979
($ Millions)

	1971	Contri-bution (%)	1972	1973	1974	1975	1976	1977	1978	1979	Contri-bution
Agriculture (2)	459	6.2	543	891	1,159	1,128	996	940	1,332	1,751	5.4
Forestry	14	0.2	16	20	27	24	34	39	37	44	0.1
Mining	1,183	16.1	1,423	1,980	2,770	3,539	3,922	5,006	5,954	7,942	24.4
Manufacturing	661	9.0	752	885	1,117	1,362	1,537	1,647	1,891	2,396	7.4
Construction	617	8.4	676	861	1,052	1,466	1,832	2,018	1,844	2,359	7.2
Transportation (3)	667	9.1	770	856	1,018	1,198	1,428	1,633	1,868	2,156	6.6
Utilities	172	2.3	180	233	269	374	459	552	677	855	2.6
Trade (4)	785	10.7	896	1,059	1,327	1,650	1,915	2,028	2,334	2,733	8.4
Finance (5)	974	13.2	1,085	1,401	2,095	2,762	3,632	4,271	5,254	6,489	19.9
Services (6)	1,334	18.1	1,460	1,662	1,982	2,433	2,834	3,255	3,704	4,213	12.9
Public Administration	485	6.6	549	624	775	973	1,112	1,269	1,407	1,594	4.9
Gross Domestic Product at Factor Cost	7,351	100.0	8,350	10,472	13,591	16,909	19,701	22,658	23,302	32,532	100.0

NOTE: Data to be revised.

(1) G.D.P. at market price is obtained by adding indirect taxes less subsidies, plus residual.
(2) Includes Fishing and Trapping.
(3) Includes Storage and Commission.
(4) Includes Retail and Wholesale Trade.
(5) Includes Insurance and Real Estate.
(6) Includes Community, Business and Personal Services.

Source: Alberta Statistical Review Annual 1980, Table 40.

TABLE 7

CENSUS VALUE ADDED IN GOODS-PRODUCING INDUSTRIES
ALBERTA
(1971 - 1980)
($ Millions)

	1971r	1975r	1976r	1977r	1978r	1979r	1980p
Mines (1) (including Milling), quarries and oil wells	1,486	5,363	6,337	7,8433	9,110	11,854	15,464
% Contribution to Total	39.8	51.2	50.9	53.9	51.4	52.7	55.2
Agriculture (2)	441	1,192	1,083	956	1,359	1,610	1,703
% Contribution to Total	11.8	11.4	8.7	6.6	7.7	7.2	6.1
Construction	895	2,056	2,937	3,397	4,279	5,441	6,630
% Contribution to Total	24.0	19.6	23.6	23.3	24.2	24.2	23.7
Manufacturing	785	1,638	1,804	2,024	2,544	3,050	3,595
% Contribution to Total	21.9	15.6	14.5	13.9	14.4	13.6	12.8
Electric Power	110	192	250	300	369	461	526
% Contribution to Total	3.0	2.0	2.0	2.1	2.1	2.1	1.9
Other (3)	13	29	36	35	43	67	84
% Contribution to Total	0.4	0.2	0.3	0.2	0.2	0.3	0.3
Total Alberta	3,732	1,070	12,446	14,553	17,705	22,483	28,000
% Contribution to Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

NOTE: Component Items may not add to totals due to rounding. r = revised; p = preliminary

(1) Includes Gas and Oil. Data relating to the production of "synthetic" crude oil have been included as of 1973.

(2) Data for Agriculture have been prepared on a value added basis commencing 1971.

(3) Comprises Logging, Fisheries and Trapping.

SOURCE: Alberta Statistical Review Annual 1980, Table 38.

plus costs of purchased services and overhead charges such as advertising, insurance, rent and indirect taxes. Comparing G.D.P. and census value added figures for agriculture and mining, it is seen that the costs of services and overhead associated with the mineral industry, in 1979, was equivalent to 49% of the G.D.P. of that industry while these costs for agriculture were equal to only 8.7% of agriculture's G.D.P.

Another estimate of the relative values of industry production is given in Table 8. Farm cash receipts increased from 795 million dollars to 3,132 million from 1971 to 1979, while the value of mineral production rose from 1,640 million to 16,845 million dollars.

These various statistics show that although the value of agricultural production rose more than threefold over the last decade, the value of mineral products increased by tenfold and has outstripped agriculture at the primary industry level.

In the manufacturing industries agriculture and mines have experienced similar percentage increases in values of products. However, the food and beverage industry retains the top position, increasing from 884 million dollars in 1971 to 3,241 million dollars in 1980, although its relative contribution fell from 42.5 percent to 30.5 percent. The value of petroleum and coal products increased from 205 million to 2,098 million but still represents less than 20 percent of the total value of the manufacturing products (Table 9). The contribution of the chemical and chemical products industry has also risen from 6 percent to 10 percent while that of the wood products industry fell from 6 percent to 4 percent over the same period. Paper and allied products contributed 3 percent in 1971 rising slightly to 3.3 percent in 1980.

In terms of labour, there has also been a shift of workers away from agriculture, the number falling from 111,000 employed in 1975 to 83,000 in 1980, a drop from 14.1 percent of the total labour force to 7.7 percent. At the same time the number employed in the other primary

TABLE 8

VALUE OF PRODUCTION - PRIMARY INDUSTRIES

1971 - 1980
($ Millions)

	1971r	1975r	1976r	1977r	1978r	1979r	1980p
Minerals							
Fuels	1,575	5,569	6,739	8,366	9,794	12,552	16,228
Non-Metallics	24	101	81	92	116	172	428
Structural Materials	42	80	114	118	177	174	189
Metals (1)	-	-	-	-	-	-	-
Total	1,640	7,550	6,934	8,576	10,087	12,899	16,845
	1971r	1975r	1976r	1977r	1978r	1979r	1980p
Farm Cash Receipts							
Total Crops	318	987	917	925	954	1,207	1,453
Livestock & Products	463	891	921	989	1,302	1,599	1,647
Other (2)	13	20	21	75	31	16	32
Total	795	1,898	1,859	1,989	2,287	2,823	3,132
	1971/72	1974/75	1975/76	1976/77	1977/78	1978/79	1979/80
Timber							
Lumber and Plywood Logs	45	53	58	89	118	141	193
Other Products	8	30	27	30	39	37	46
Total	53	83	85	119	157	178	239

r = revised p = preliminary
(Footnotes continued on next page)

TABLE 8 (cont'd)

NOTE: Component items may not add to totals due to rounding.

(1) Value of metals is less than one million dollars.

(2) Other includes Forest and Maple Products, Provincial Income Stabilization Programme (where applicable), Dairy Supplementary Payments and Deficiency Payments.

SOURCE: Derived from Alberta Statistical Review Annual 1980, Tables 60, 77 and 92.

TABLE 9

VALUE OF PRODUCTION - NON-PRIMARY INDUSTRIES

1971 - 1980

($ Millions)

Industry	1971	1975	1976	1977r	1978r	1979r	1980p
Manufacturing							
Food & Beverage Products	884	1,684	1,715	2,059	2,524	2,961	3,241
Rubber & Plastic Products	29	62	69	N/A	N/A	N/A	N/A
Leather Products	N/A	9,066	11	12	17	21	17
Textile Products	15	33	41	52	60	68	85
Wood Products	128	259	296	329	388	427	425
Furniture & Fixtures	20	50	55	59	69	87	109
Paper & Allied Products	61	175	197	210	241	305	351
Printing, Publishing & Allied Products	69	136	163	192	241	286	350
Primary Metal Products	126	324	270	292	375	499	660
Metal Fabricating Products	137	288	328	334	442	535	590
Machinery	41	127	150	156	240	283	473
Transportation Equipment	88	204	224	165	190	184	209
Electrical Products	31	82	77	87	75	94	124
Non-Metallic Mineral Products	120	231	299	336	460	557	579
Petroleum & Coal Products	205	700	914	1,151	1,408	1,732	2,098
Chemical & Chemical Products	125	281	312	417	609	740	1,063
Miscellaneous Manufacturers	16	23	37	43	52	59	70
Total	2,081	4,726	5,216	6,020	7,426	8,995	10,629

TABLE 9 (cont'd)

Electricity	1971	1975	1976	1977	1978r	1979p
General Service (1)	82	165	219	260	328	372
Domestic & Farm	43	77	98	120	152	177
Street Lighting	4	7	8	11	14	15
Total Sales to Ultimate Customers	129	249	326	391	494	565
Sales to Other Provinces	1	-	1	2	1	4
Total Sales	131	249	327	394	495	569

Construction	1971	1976	1977	1978	1979r	1980p
Building	865	2,573	2,941	3,831	4,717	5,074
Engineering	981	2,625	3,184	3,579	4,656	6,145
Total Construction	1,846	5,197	6,125	7,410	9.373	11,218

Retail Trade	1972 (2)	1975	1976	1977	1978	1979r	1980p
Total Trade	2,728	4,557	5,290	5,927	6,798	8,051	9,355

r - revised p - preliminary

NOTE: Component items may not add to totals due to rounding.

(1) Excludes sales to industrial establishments with generation and/or distributing facilities.

(2) Due to major revisions to survey methodology, comparable data not available for 1971.

SOURCE: Derived from Alberta Statistics Review Annual 1980, Tables 78, 82, 84 and 103.

industries (mines and forestry) increased from 28,000 (3.5 percent) to 65,000 (6.1 percent). Other industries grew in numbers but showed little change in percentages of the total labour force. Services showed the largest increase from 206,000 to 302,000 workers (Table 10).

The food and beverage industry employed 16,118 workers in 1978 with salaries and wages valued at $235.9 million. By comparison the petroleum and coal products industry employed 1,990 persons with salaries and wages of $41.2 million and the chemical and chemical products industries employed 3,524 persons with wages and salaries of $69.3 million. Comparative figures for the wood product industries are 6,571 employees and $98.7 million in wages and salaries.

Forestry in Alberta provides employment for some 10,000 persons or 7.25 percent of the jobs related to the four primary industries (Reed, 1979). Agriculture ranks first (99,800 jobs) followed by mining (43,000), then forestry and fourth fishing (2,200 jobs). Because forest lands are concentrated in the north, the industry ranks second in the Peace River Region and third in the Athabasca River, Edmonton - Lloydminster, and Parks Regions. Its contribution is negligible in the other regions.

The 1980 volume of production was 6,633.733 cubic metres (234,451,684 cubic feet) or approximately 4 percent of the total Canadian harvest of 1979 (Alberta Energy & Natural Resources, 1981). The total value of production in 1979/1980 was $239 million or roughly 1% of the national value of forest product shipments for 1979. This value represents an increase of 350 percent from $53 million in 1971/72. Forestry's contribution to Alberta's G.D.P. is fairly small, being only 0.2 percent of the total in 1971 and falling to 0.1 percent in 1979. Logging, fishing and trapping together comprise less than 0.5 percent of the census value added or net dollar value for goods produced.

TABLE 10

EMPLOYED LABOUR FORCE BY INDUSTRY, ANNUAL AVERAGES
ALBERTA
1975 - 1980
(Thousands)

	1975	1976	1977	1978	1979	1980
All Industries	788	837	868	915	976	1,072
Agriculture	111	116	86	84	83	83
Other Primary	28	32	41	51	57	65
Manufacturing	71	76	78	77	82	100
Construction	64	77	83	92	106	105
Transportation, Communication & Other Utilities	69	70	74	83	89	94
Trade	147	150	165	164	176	193
Finance, Insurance & Real Estate	36	38	46	47	52	57
Service	206	220	236	257	270	302
Public Administration	57	58	58	59	60	69

NOTE: Comparable data not available prior to 1975 due to major revisions to Statistics Canada's Monthly Labour Force Survey.

SOURCE: Alberta Statistics Review Annual 1980, Table 21.

At the manufacturing level the wood products industry accounted for 6 percent of total manufacturing goods in 1971 at a value of $128 million. The value increased to $425 million by 1980 but relative importance fell to 4 percent. Paper and allied products and printing, publishing and allied products together accounted for another 6 percent in 1971 and 1980. The wood products industries provided 6,571 jobs with salaries and wages of $98.7 million, paper and allied products contributed 2,338 jobs at $39.3 million, and printing, publishing and allied industries 5,662 jobs at $82.5 million (Table 11).

TABLE 11

SUMMARY OF FORESTRY STATISTICS (1)

($ Million)

	1971	1975	1979
Forestry			
Gross Domestic Product	14	24	44
% Contribution	0.2	0.1	0.1
Census Value Added (2)	13	29	67
% Contribution	0.4	0.2	0.3
Value of Shipments	53	83	239
Manufacturing			
Wood Products	128	259	427
Paper & Allied Products	61	175	305
Printing, Publishing & Allied Products	69	136	286
Total Manufacturing	258	570	1,018

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(1) Taken from Tables 6 to 8.

(2) Comprises Logging, Fisheries and Trapping.

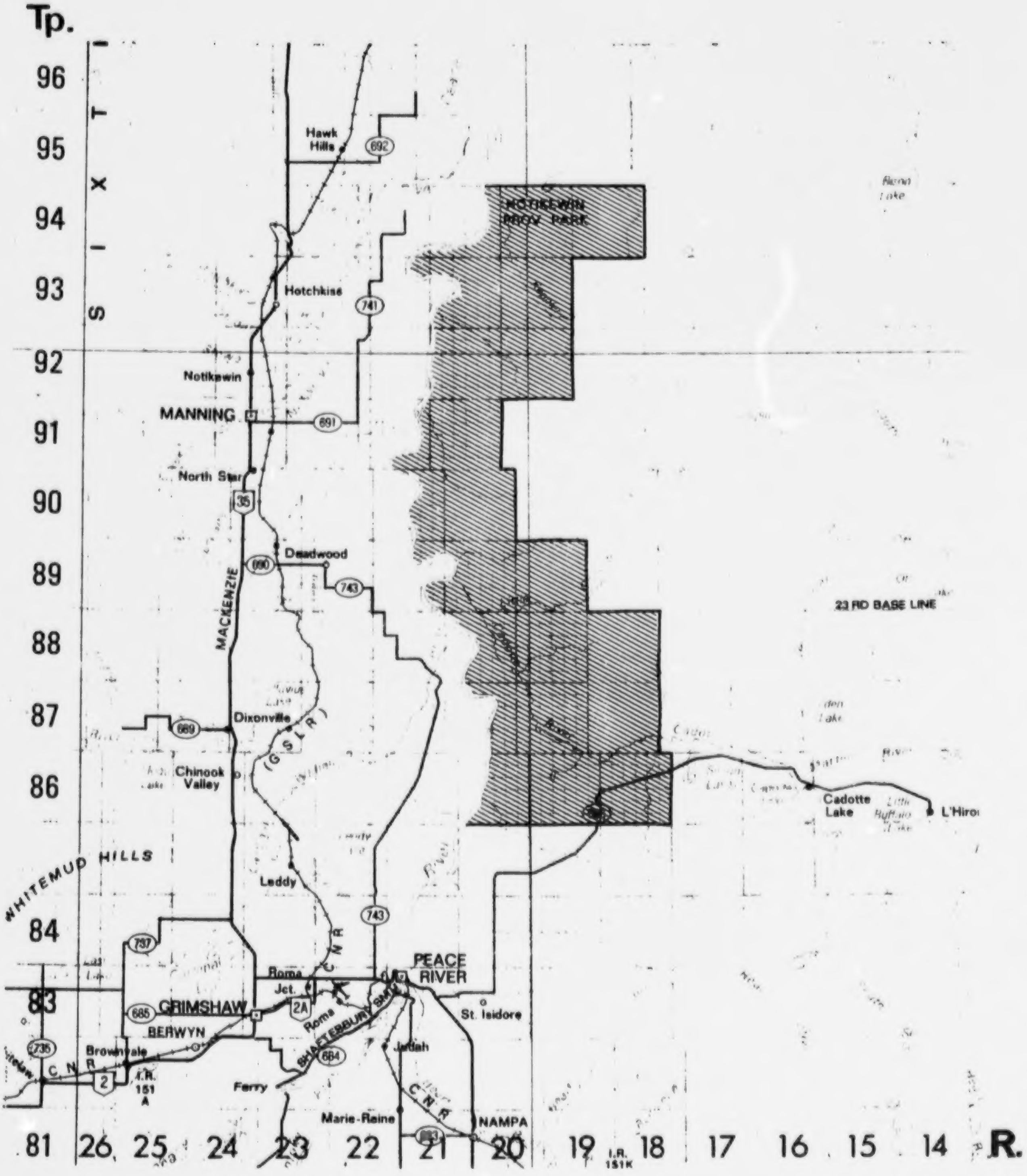
3. PHYSICAL DESCRIPTION OF STUDY AREA

Location

The Cadotte study area is located in the Peace River Region of northwestern Alberta. Immediately east of the Peace River and north of the Three Creeks Grazing Reserve, the study area lies between Townships 87 and 94 and extends roughly two or three Townships east taking in Ranges 18 - 21, W5M. Approximately 437,760 acres make up the study area of which 51 percent or 224,000 acres are potentially arable. Figure 1 identifies the study area.

Climate

Farming in a continental climate such as Alberta's depends on many climatic factors including: the frost-free period, mean monthly temperatures, precipitation, hours of daylight, and amounts and dryness of winds. Erratic weather conditions such as late frosts, early snowfalls or drought can have a marked effect on crop yields (Alberta Agriculture). Temperature recordings over the years for Keg River west of the area indicate that the study area has a cold winter with mean January temperatures of -21°C and cool growing seasons with mean July temperatures of 16°C which favor cultivation of cool season crops (Alberta Agriculture; Alberta Energy and Natural Resources, 1977; Scheelar and Odynsky, 1968). Day length substantially increases as one moves into northern Alberta. For example, Fort Vermilion has 538 daylight hours in July vs Lethbridge's 488 daylight hours. The long summer days in the study area will have a marked affect on promoting plant growth - a compensation for the lower mean summer temperatures (Alberta Agriculture). Precipitation is adequate in the area with averages of 14 to 18 inches per year. About one half of the water held in snow is lost in the heavy spring runoff and is not available for plant growth (Alberta Energy and Natural Resources, 1977). Dry, warm winds are not common in the area, therefore high evaporation causing severe drying in the spring and summer is not a problem (Alberta Agriculture).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684
Judah
St. Isidore
Ferry
Marie-Reine
NAMPA
683
C N R
Cadotte Lake
L'Hiro
81
26
25
24
23
22
21
20
19
I.R. 151K
18
17
16
15
14
R.

FIGURE 1.

LOCATION OF STUDY AREA

Scale 1:750,000
West of Fifth Meridian

Generally the Peace River basin section of the study area has a frost-free period of 75 - 90 days while the remaining area is cooler with 60 - 75 frost-free days (Alberta Energy and Natural Resources, 1977; Bentley et al, 1971). A killing frost (-2°C) free period is usually 3 - 4 weeks longer than the frost-free period. Within the area, variations in the frost-free days may be due to elevation, topography, and air drainage (Scheelar and Odynsky, 1968). Climatic data are presented in Table 12.

It is expected that if the land is cleared for agriculture there will be an improvement in the climatic conditions over time.

Topography and Drainage

The most prominent feature in the study area is the Peace River valley which is V-shaped with extremely unstable slopes (Alberta Energy and Natural Resources, 1977). Throughout the remaining area the land consists of flatlands, gently sloping areas, high plain remnants or till plains, and valleys of major streams (Scheelar and Odynsky, 1968). The drainage of the area is provided by the Peace River and its tributaries. Slides and creeps are common on all erosion slopes, especially along river and stream valleys. Local drainage varies considerably throughout the area due to the topography. Hill tops are usually very dry while low lying areas are usually flooded - in fact, extensive interconnecting muskegs are common (Alberta Energy and Natural Resources, 1977; Scheelar and Odynsky, 1968).

Vegetation

The study area lies within the Boreal Forest Region of Canada. A mixed forest is the native vegetation with trembling aspen (Populus tremuloides) being the dominant species. Other tree species such as balsam poplar, white spruce, black spruce, tamarack, jack and lodgepole pines, white birch, willow, and elder occur either in mixed stands or as the dominant cover in some localities (Scheelar and Odynsky, 1968). Marketable stands of white spruce are found in some

Table 12
Climatic Conditions

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
Mean Daily Temperatures (^{0}F)													
Fairview	1.2	9.8	19.5	36.2	49.8	56.8	60.9	58.6	49.6	39.0	20.2	8.2	34.2
(30 years between 1941 and 1970, or more)													
Keg River	-6.7	1.5	15.1	34.1	48.4	56.1	60.3	57.4	48.2	37.5	15.6	-0.1	30.6
(25 - 29 years between 1941 and 1970)													
Mean Total Precipitation (Inches)													
Fairview	1.09	1.15	0.94	0.82	1.45	2.34	2.46	1.87	1.16	0.99	1.19	1.17	16.63
Keg River	0.86	0.85	0.80	0.78	1.40	2.10	2.34	2.03	1.76	0.84	1.08	1.03	15.87
(25 - 29 years between 1941 and 1970)													
Number of Days with Frost													
Fairview	31	28	30	22	6	¤	0	¤	5	19	28	31	200
Keg River	31	28	30	25	13	3	¤	2	11	23	28	30	224
(25 - 29 years between 1941 and 1970)													

[1] - Length of Period of Records.

Source: Alberta Energy & Natural Resources, April, 1977. Biophysical analysis and evaluation of capability. Dixonville area.

locations in the area. Also a reforestation area of white spruce extends north of Three Creeks Grazing Reserve into Townships 87 and 88, Range 19, W5M (Alberta Agriculture, 1982). In the understory of the forest, in open areas, and along eroded stream banks grow shrubs such as rose, raspberry, gooseberry, cranberry, chokecherry, saskatoon, and hazlenut. Different species of herbs can also be found. In the poorly drained areas sedges, slough grass, mosses, dwarf birch, black spruce, rushes, reeds, and labrador tea occur (Scheelar and Odynsky, 1968).

Soil

The Canada Land Inventory Soil Capability for agriculture groups mineral soils into seven classes according to their potential and limitations for growing agricultural crops. The classes are an actual assessment of the degree of limitation; subclasses are also used to describe the kind of limitation. Fourteen subclasses or kinds of limitations are recognized; however, they can be broken down into three main categories: climatic limitations such as lack of precipitation and short growing seasons, soil limitations such as slow permeability and excessive soil salinity, and landscape limitations such as stoniness and adverse topography. The first four classes indicate arable lands suitable for production of cultivated crops. Note that the suitability decreases as the class numbers increase. Therefore, Class 1 indicates no significant limitations for production of crops, Classes 2 and 3 have moderate limitations and moderate to moderately severe limitations respectively which restrict the range of crops grown and may require special conservation practices. Class 4 indicates marginal lands for crop production. Here a narrow range of crops are grown with low yields and a high risk of crop failure; also special conservation practices are needed. Classes 5 to 7 are not considered suitable for annual cultivation due to severe limitations. However, Class 5 can be used for permanent production of pasture and hay, and Class 6 is capable for use as native grazing land. Class 7 land is unsuitable for any agricultural use and should be used for wildlife, recreation, etc. An organic soils class also exists which includes all organic soils such as peat, muskeg and meadows. Like Class 7 it has no potential for any agricultural use (Alberta Environment, 1977).

Alberta is broken down into five different soil groups with the Luvisolic or Grey Wooded soil group having the largest acreage comprising 31.8 percent of the total land area. In fact 80 percent of Alberta's potentially arable uncultivated land is on Grey Wooded soils. However, because 71 percent of these soils are rated as Class 4, most of this potentially arable land would be limited for cereal and oilseed production but would have potential for grass and legume production (Alberta Agriculture). The study area is composed almost exclusively of Grey Wooded soils with a few localized areas of Dark Grey and Dark Grey Wooded soils and Organic soils (Scheelar and Odynsky, 1968).

In the study area Grey Wooded soils along the river and stream valleys are rated Class 6 and 7 due to the severe topography limitations. Small pockets of Organic and Class 5 soils with severe climatic limitations also exist along the rivers and streams. Just east of the Peace River the Grey Wooded soils are composed of approximately 80 percent Class 3 and 20 percent Class 4 with the most north-western portion of the area composed of 80 percent Class 2 and 20 percent Class 4. Farther east the soil quality deteriorates to mainly Class 4 with small localized pockets of organic soils. Climatic conditions (short growing season) are the major limitations on Classes 2 and 3 while landscape (excess moisture) and soil (undesirable soil structure and/or low permeability) are the major limitations on Class 4 soils.

From the above discussion it is apparent that highly potential arable land is limited - 51 percent of the total study area is potentially arable as mentioned previously. Very general figures indicate that 40 percent Class 3 and 60 percent Class 4 soils make up this potentially arable land (Canada Land Inventory Maps).

Grey Wooded soils located in northern Alberta and in central Alberta west of Edmonton are the most common soil group in the forest region. Development of soils depends on factors such as climate, vegetation, and topography acting on parent material over time (Alberta Agriculture). In the forest regions moist conditions prevail due to small amounts of wind and lower temperatures which result in lower rates of evaporation and transpiration. Consequently, fallen leaves and needles almost completely decompose leaving the topsoil beneath the decomposing leaf mat low in organic matter or humus. When plowed this Grey Wooded soil is grey due to the low humus content and leaching; when dry it is usually ash-like. Being low in humus, Grey Wooded soils do not have a high natural fertility and as a result crop yields on newly broken land are usually lower than on humus rich soils such as soils developed on grasslands. Without careful management Grey Wooded soils will decline after very few crops resulting in very poor yields. Grey Wooded soils are separated from Black soils, which developed on grasslands, by two other soil groups, the Dark Grey Wooded soils and the Dark Grey soils. These two soils have intermediate characteristics and appearances between those of Grey Wooded and Black soils. The Dark Grey Wooded and Dark Grey soils were probably once grassland soils with high amounts of humus in the topsoil but have recently been invaded by a forest. The Dark Grey soils have a higher humus content compared to the Dark Grey Wooded soils which have a little more humus than Grey Wooded soils (Bentley et.al., 1971).

In its natural state the profile of a Grey Wooded soil consists of a surface layer of fallen leaves and needles underlain by a fibrous mat of partly decomposed organic matter. Underlying these horizons is a dark layer usually less than one inch thick composed of humus and mineral matter. The next horizon is grey due to its low humus content and leaching of clay downwards. When dry this horizon crushes to an ash-like powder and when wet the mineral matter is like a heavy paste that becomes very firm and hard when dry. This is the horizon exposed when plowed. The subsoil horizon is brown, grayish brown or brownish grey in color and contains the clay and other minerals leached from the upper horizons. The structure of this horizon is such, that when dry, the soil aggregates become so hard that roots may have difficulty penetrating it. The next horizon is a deep lime layer, formed as a result of an accumulation of calcium carbonate that has moved down through the horizons over time (Bentley et.al., 1971).

Access

A paved secondary road (686) runs from Highway 2 just east of Peace River to Cadotte Lake and passes south of the study area. Existing access into the study area is very limited. A forestry road, off 686, passes through the Three Creeks Grazing Reserve and continues into the southern section of the study area including Townships 87 and 88, Range 19, W5M, where logging and reforestation are taking place. Current access to the central and northern part of the study area is only possible by air or river boat along the Peace River (Alberta Energy and Natural Resources, 1977).

Economic Activities

Apart from reforestation in two townships by the Forestry Department, the other activity is logging through quotas and permits. There are no forest management agreements in the area and thus the loggers are not responsible for inventory and management planning. Timber quotas give the owner a right to a certain proportion of the allowable cut on the total management unit. Quotas are sold by competitive bid, generally last 20 years, and are renewable if all conditions of the agreement have been met.

Timber permits are short term and provide authority for the holder to harvest a specific stand of timber. Commercial timber permits are issued for the removal of dead, diseased, or endangered timber. In general, local permits are issued to local residents who wish to harvest timber for their own use (Environment Council of Alberta, 1981).

4. ANALYSIS OF COSTS AND BENEFITS

4.1 Current Forestry Use

The study area forms part of Forestry-Management Units 4 and 5 in the Peace River Forest (P4 and P5). The total area of P4 is 382 thousand hectares of which 24 percent is classed as productive and 18 percent potentially productive forest. P5 is comprised of 349 thousand hectares of which 24 percent is classed as productive and 14 percent potentially productive.

The gross 1971 forest inventory volumes for the two units were 142,571 million cubic feet coniferous and 193,736 million cubic feet deciduous in P4; and 89,352 million cubic feet coniferous and 156,914 million cubic feet deciduous in P5. The net annual allowable cuts are P4 1,995 million cubic feet (56,435 m^3) coniferous and 3,958 million cubic feet deciduous; and P5 1,251 million cubic feet coniferous and 3,205 million cubic feet deciduous (Alberta Forestry Service, 1982).

In effect however, there are no harvests from P5 and only coniferous timber is harvested from P4. There are no Forest Management Agreements in either P4 or P5, and consequently, no large wood processing facilities in the immediate area. Loggers are not responsible for inventory and management planning.

Two companies, Buchanan Lumber and Boucher Brothers Lumber together hold quotas totalling just over eight million board feet (40 thousand m^3) equivalent to 73 percent of the coniferous annual allowable cut in P4 (Alberta Forest Service, 1971 and 1982). Buchanan has a quota of 4.08 mm fbm (20,627 m^3) and Boucher Brothers 4.03 mm fbm (20,390 m^3). Additional timber is obtained through timber permits and salvage. Both companies are small Alberta businesses consisting of logging and sawmilling operations.

Logging Operations

One quarter of the timber needed to operate Buchanan's High Prairie sawmill comes from the Peace River Forest - Management Unit 4, with the remaining timber coming from areas closer to High Prairie. Boucher Brothers Lumber company relies on timber from P4 to operate their sawmill located at Nampa.

Companies acquire timber from this area by three methods:
(1) Timber quota - both companies hold their own timber quota which allows them each an average annual cut of 4.0 million board feet in their specific quota area;

(2) Salvage - timber is salvagable for only 1 year after a forest fire. As a result, lumber companies can go into a burnt out area to collect timber even though it is not their quota area;

(3) Permits - many people, especially farmers, in the Peace River area acquire permits to cut timber outside of areas held by quota holders. Lumber companies may hire these permit holders via contracts.

Last timber year, Buchanan cut 7.0 million board feet in Management Unit 4, the major supply areas being Townships 89 and 90, Range 14 and 15 W5M and Township 87, Range 14 and 16 W5M. This is outside the study area. This 7.0 million board feet came from Buchanan's total quota for a period of 5 years. In the last timber year (May 1, 1981 - April 30, 1982), Boucher Brothers took 5.0 million board feet of timber from Management Unit 4 - major supply areas being Township 89, Range 18 and 19 within the study area. Of the total, 2.0 million board feet came from their quota while the remaining 3.0 million board feet came from permits.

As a quota holder, each company is given a specific area in which to cut. It takes approximately 3 years for companies concerned to harvest all viable trees in a specific area. At this time, another area is assigned to them. A forest fire in an assigned area is very costly in terms of viable trees destroyed, average annual cuts not met and money lost in survey and license fees. Thus forest fires present a considerable risk to quota hoders.

Together, these two companies employed 50 to 60 people last year working 8 to 10 hours a day at $10.00 to $12.00 per hour. Employment spans 3 to 4 months in winter. Crews move into an area and begin to cut when the ground is sufficiently frozen allowing machinery and vehicles to move over the muskeg easily - usually in mid-November. Cutting continues until spring thaw - usually to mid-March.

These basic forestry jobs provide employment equivalent to 16 man-years per annum and generate another 100 non-basic jobs elsewhere in the economy, equivalent to 29 man-years. These spin-off jobs reflect a multiplier of 1.7 to 2.0 and represent employment in industries such as services, trade, accomodation and administration.

In the field, last timber year, felled, skidded and piled timber cost $40.00 to $50.00 per thousand board feet. This production cost includes variable and fixed labour, machinery and vehicle costs. Other major costs in the field include the quota, survey and license costs. All quota holders have to bid on their quota. On the average, quota costs for the companies in P4 are equivalent to $300,000 for a period of 20 years. After 20 years, another bid has to be made. Each time a company moves into a new area, a $16,000 license has to be bought from the Alberta Government. Included in this license fee is a $6,000 cruising charge (marking of boundaries), an $8,000 performance guarantee (returned after the area is vacated), and a $2,000 fee for miscellaneous items such as maps. $18,000 is also needed for surveying and mapping all viable cut locations within the area. Therefore, license and survey costs total $34,000 every 3 years or $11,333.33 per year. Combining quota, license and survey costs, the cost of timber in the field increases by $5.00 per thousand board feet. Another estimate of these overhead costs is $20.00 per thousand board feet bringing the total closer to $60.00 to $70.00 per thousand board feet. Other costs in the field are the costs of establishing and maintaining forest roads. Roads built by lumber companies are private roads and the companies can charge other lumber companies and oil companies to use them. Therefore, depending on miles of road built and maintained, the amount of activity from other companies on lumber company roads, and the amount each company travels on other company roads per timber year, each company can either make or lose money.

Estimates of 1981/1982 costs in P4 are provided in Table 13, road costs are not included. One company estimated costs of $[illegible],000 per mile and an annual maintenance cost of $333. These estimates appear to be extremely low. Another estimate for forest road costs is $30,000 per kilometer for a gravel roadway 6m wide (1.5 lanes) - Department of Transportation, 1982. Forest road standards would be below graded local road standards and in fact would not require gravelling, thus costs would be somewhat lower than this latter estimate. Lumber companies clear forest access roads and also use seismic lines for logging. Road costs are ignored on the assumption that revenue from other companies using forest roads is equal to the cost of maintaining these roads.

Sawmill Operations

Timber is hauled some 80 to 160 kilometers to High Prairie and 110 to 115 kilometers to Nampa; hauling costs are $30.00 to $36.00 per thousand board feet. The main products are dimensional lumber (2'x 4', 2'x 6', and 2'x 3') and board lumber (1'x 4', 1'x 2', and 1'x 3'), and the 1981/82 market price was $150.00 per thousand board feet. With a gross harvest of 12 million board feet from Management unit P4, the gross revenue was approximately 1.8 million dollars. Approximately 50% or 0.9 million dollars originated in the study area. Gross revenue approximates $7.66 per productive acre, or when based on the coniferous inventory alone, $18.00 per coniferous acre.

Sawmilling costs of $70.00 to $85.00 per thousand board feet put the total cost of production at $140.00 to $176.00 per thousand board feet. At the lowest cost estimate a profit of $5.00 to $10.00 per

TABLE 13

ESTIMATED COSTS AND RETURNS FOR LOGGING AND SAWMILLING - FORESTRY MANAGEMENT UNIT P4 (1981 - 1982)

	Value Per Thousand Board Feet		Calculated Value Per 12.0 million Board Feet	
	Excludes[1] Overhead	Includes[2] Overhead	Excludes[1] Overhead	Includes[2] Overhead
	($)		($'000)	
Value of cut timber felled, skidded and piled	40.00- 50.00	55.00- 62.00	480-600	660-744
Cost of hauling to sawmill	30.00- 36.00	30.00- 36.00	360-432	360-432
Value of cut timber in yard	70.00- 86.00	85.00- 92.00	840-1032	1092-1104
Cost of operating sawmill	70.00- 85.00	70.00- 85.00	840-1020	840-1020
Break even price	140.00-171.00	155.00-176.00	1680-2052	1944-2112
Market Price	150.00	150.00	1800	1800
Profit/Loss	10.00-(21.00)	5.00-(26.00)	120-(252)	144-(312)

1. Includes labour, machinery and vehicle costs, does not include road, quota, license, or survey costs.

2. Includes - quota cost of $15,000 (300,000 / 20 years)
   - license and survey costs of $11,333.33 (34,000 / 3)

SOURCE: Personal communication with sawmilling companies.

thousand board feet would apply. However, at higher estimates (including quota, license and survey costs) there is a loss of $26.00 per thousand board feet. Hence, a price increase of $26.00 per thousand board feet would be needed to cover all costs. For an average annual harvest of 12 million board feet the loss is approximately $228,000 for P4 or $0.97 per productive acre. Based on the coniferous inventory alone the loss is about $2.30 per acre.

Future Plans

Due to a depressed lumber market and high interest rates in the last two years, neither company has cut their maximum quota in P4. No immediate recovery was foreseen, particularly with the current U.S. protectionist attempts, and in fact there may be a reduction in harvest next year. More details on forest marketing condtions are given in Appendix I. There were mixed views on the future, one company foreseeing widespread bankruptcy before things improve, the other more optimistic for long term prosperity.

4.2 Agricultural Development

The study area has been described in Chapter 3 and in more general terms, agriculture on Grey Wooded soils is discussed in Appendix II. Of all the Foresty-Management Units in the province, P4 has the largest undeveloped land base classed as 4 or better for Agriculture. The total area of P4 is 382 thousand hectares of which 65 thousand hectares are Class 1 to 3 and 95 thousand hectares are Class 4. Of the 349 thousand hectares in P5, 22 thousand hectares are Class 1 to 3 and 51 thousand hectares are Class 4. Most of this land is in the Green Zone, with less than one thousand hectares in the Yellow Zone.

South of the study area is the Three Creeks Grazing Reserve, and further south is an area of cleared and developed farm land with some clearing still being done at the fringe areas.

Access to the study area is a major limitation to development for agriculture. The areas south of Three Creeks Grazing Reserve are served by a paved secondary road and there is access from this road via a forest road. There is no river crossing to the study area north of the town of Peace River. Provision of infrastructure - roads and power - would be major costs for establishing agriculture in the area.

Infrastructure Costs

Road costs for the area are based on the following assumptions:

i) Approximately 14 townships to be settled;

ii) Approximately 500 farms of roughly one section per farm;

iii) A road system of: 48.3 kilometers (30 miles) of graded secondary roads at $100,000 per kilometer (running north from Three Creeks Grazing Reserve, or east from Peace River); 38.6 kilometers (24 miles) of graded local roads at $50,000 per kilometer; 804.6 kilometers (500 miles) of internal graded local roads (every two miles north-south and east-west); and upgraded access of 16.1 kilometers (10 miles) from either the Manning area or the Three Creeks area;

iv) Three alternate access methods are considered:

  a) from north of the Three Creeks Grazing Reserve;
  b) from east of Manning by ferry; and
  c) from east of Manning by bridge across the Peace River;

v) River crossings will be required at Cadotte and Little Cadotte Rivers.

Road cost estimates are presented in Table 14.

TABLE 14

ROAD COST ESTIMATES

Item	Kilometers (Miles)	Cost/ Kilometer (Mile)	Total Cost	Average Cost Per Farm
			($)	
Alternate A				
Graded Secondary Road	64.4	100,000		
(RCU 209 gravel standard)	(40)	(160,000)	6,400,000	
Graded Local Road	843.2	50,000		
(RCU 207 gravel standard)	(524)	(80,000)	41,920,000	
Total Road Costs			48,320,000	96,640
Cadotte and Little Cadotte River Crossings			1,100,000	2,200
TOTAL Cost Alternate A			49,420,000	98,840
Alternate B				
Ferry Crossing[1]			640,000	
Roads and Bridges			49,420,000	
TOTAL Cost Alternate B			50,060,000	100,120
Alternate C				
Bridge Crossing			17,000,000	
Roads & Bridges			49,420,000	
TOTAL Cost Alternate C			66,420,000	132,840

1. There would be additional maintenance costs of $180,000/year, averaging $360 per farm established.

SOURCE: Department of Transportation (1982). Personal communications.

Power costs for the area are based on the following assumptions:

i) Power lines would follow the main north-south and/or east west roads and all the local east-west roads.

ii) Upgrading the existing power system outside the area will be required.

Power cost estimates are presented in Table 15.

If the total area is developed and settled as one project, (single phase) the road and power costs would be: $106,960 per farm where access is from Three Creeks; $108,240 per farm where access is from Manning via a ferry across Peace River; and $140,960 per farm where access is from Manning via a bridge. These are summarized as follows:

Alternate	Roads	Power	Total	Per Farm
		($'000)		
A (Three Creeks)	49,420	4,062	53,482	106.96
B (Manning-ferry)	50,060	4,062	54,122	108.24
C (Manning-bridge)	66,420	4,062	70,482	140.96

Access from the south, through the Three Creeks area is the least expensive but not the most effective method. Grain would be trucked to elevators south of the settlement area and the distances would range from a minimum of 48 to 64 kilometers (30 miles to 40 miles) to a maximum of 145 to 161 kilometers (90 to 100 miles), depending on farm location and on whether trucked to Nampa or Grimshaw. The alternate access across the Peace River to Manning reduced the distances by almost 32 kilometers (20 miles). For farms in the northern part of the area, the distance to markets would be 24 to 40 kilometers (15 to 25 miles), for southern farms the distance would be 96 to 128 kilometers (60 to 80 miles).

TABLE 15

POWER COST ESTIMATES

Item		Unit Cost (per mile)	Total Cost	Averg. Cost Per Farm
			($)	
Upgrading prior to Development	30 miles (48.3 km)	15,000	450,000	
Rural Distribution Lines (14,400 Volts)	300 miles (483 km)	6,400	1,920,000	
Farm Service from Road to Farm[1]	500 connections	3,000	1,500,000	
Sub Total:			3,870,000	7,740
Contingency of 10% (For River Crossings)			192,000	
TOTAL Cost:			4,062,000	8,124

1. Includes transformers, anchors and 500 feet of line.

SOURCE: Alberta Power (1982). Personal communication.

Although the cost associated with erecting a bridge across the Peace is 34 percent higher than that of establishing access from the south, in the longer term, access to Manning would be necessary for successful settlement of the northern township in the study area.

Phasing development and settlement over a number of years is a possible alternative. Development of the southern part of the area would be practical with access from the south alone. Total initial cost of infrastructure development would be lower but the cost per farm would be higher. Assuming that 100 farms are established, and access is from the south via Three Creeks, the following costs would apply.

Road Costs

1.	Graded Secondary Road - 16.1 kilometers (10 miles) of upgrading to access the area and 16.1 kilometers (10 miles) of main service road. Total of 32.2 kilometers (20 miles) at $160,000/mile	$3,200,000
2.	Graded Local Road - 161 kilometers (100 miles) of internal roads Total of 161 kilometers (100 miles at $80,000/mile)	$8,000,000
3.	Cadotte River Crossing	$ 550,000
	TOTAL COST	$11,750,000
	AVERAGE COST PER FARM	$ 117,500

Power Costs

1.	Upgrading 48.3 kilometers (30 miles at $15,000/mile)	$ 450,000
2.	Rural distribution lines, 86.9 kilometers (54 miles at $6,400/mile)	$ 345,600
3.	Individual farm service 100 farms at $3,000/farm	$ 300,000

4. Contingency of 10% on distribution lines cost	$ 34,560
TOTAL COST	$1,130,160
AVERAGE COST PER FARM	$ 11,300
TOTAL COST - ROAD AND POWER	$12,380,000
AVERAGE COST PER FARM	$ 128,800

The initial average cost per farm, when establishing 100 farms, is considerably higher than the average cost when establishing 500 farms because upgrading and river-crossing costs are spread over a smaller number of farms. However, if developing 100 farms is viewed as a first phase in the total development of 500 farms, then these upgrading and river crossing costs can justifiably be averaged over the 500 farms and unit costs would remain at the lower level of $106,960 rather than $128,800 per farm.

1000 Acre Farms

Using the alternate assumption of 1000 acres per farm, the infrastructure costs would be somewhat different. Establishment of 250 farms, each occupying two sections, would require 50% of the internal roads and power connections originally estimated. This would reduce total costs by $20,750,000, representing a road cost reduction of $20,000,000 and a power cost reduction of $750,000. However, per farm costs would increase by approximately 30 to 40% as follows:

Alternate	Per Farm Costs (500 Farms)	Per Farm Costs (250 Farms)	Increase
		($'000)	
A (Three Creeks)	106.96	130.93	23.97
B (Manning-ferry)	108.24	133.49	25.25
C (Manning-bridge)	140.96	198.93	57.97

Cost and Return Estimates

Farming in the Peace River Region has developed into a system in which grain production is the principal activity. Livestock production is somewhat limited due to a number of factors; these include climatic conditions, distance from market and market prices. In general, farmers in the Peace River Region have off-farm jobs out of necessity and work off the farm in the winter months, thus livestock production is not very attractive. For these reasons, the cost and revenue analysis for this study will be restricted to crops, the assumption being that the main type of development will be cash cropping.

The approach used in determining cost and return estimates is one in which published consensus studies and specific area studies were used and modified by informed judgement and discussion with professionals working in the area.

Selection of crop yields is subject to much discussion. Attempts have been made to link productivity to soil classes through some rating system. Various methods of assessing agricultural suitability have been developed:

o The Land Capability Rating System for Agriculture is perhaps the most commonly used system. It was established as part of the Canada Land Inventory and rates the potential of soils to support agricultural production. The class value indicates the soil's natural ability to be agriculturally productive by rating the intensity of the physical limitations. Sub-classes describe the kinds of restrictions, rather than the degree, that limit the soil's potential for production. Classifications are based on the natural state of the land and artificial improvements are not considered. Ratings are from Class 1 (no significant limitations in use for crops) to Class 7 (no capability).

- The Storie Rating Index, another common system is comparable to the CLI system. Rating is in reverse order, with the most suitable land indexed at 7 - 8 and non-agricultural land indexed at 1.

- The Public Lands Division (Alberta Energy and Natural Resources) Soil Rating Schedule assigns percentage ratings to five soil characteristics which affect the agricultural suitability. These are a) Great Group (soil zone); b) profile variation c) texture; d) stoniness and; e) topography. The basic index for a unit represents the product of all factors multiplied by 100. Soils with a basic index of 24 or greater are considered arable and are comparable to soils of CLI ratings 1 - 4. Soils rated less than 24 are non-arable.

- The Ecological Land Classification System identifies vegetative cover, land forms, topography, drainage and soil subgroup for each ecological unit at a scale of 1:100,000. Each ecological unit can be rated on the basis of its potential for a specific land use, whether agriculture, pasture, coniferous timber production, etc. The ecological land classification for tilled cropping is based on the Public Lands Schedule and the ratings are HIGH, MODERATE, LOW or NOT-CAPABLE. Soils in the LOW category are sub-divided into LOW-HIGH, LOW-MODERATE, and LOW-LOW.

- The Farmland Assessment Rating is used by the Department of Municipal Affairs for tax assessment purposes. Each privately owned parcel of land is assessed as to its agricultural potential productivity and given a percentage rating. Alberta Hail and Crop Insurance Corporation assigns each section of land insured a soil productivity rating based on the assessment by the Department of Municipal Affairs. The ratings are designated A to E, with A being the highest productivity level.

These various systems of soil productivity ratings are compared in Table 16. It must be emphasized that this comparison is only approximate and should not be strictly applied to any specific case, but could be used for broad productivity comparisons only.

For the study area neither ecological land classification ratings nor farmland assessment ratings are available. The only system currently available is the Canadian Land Inventory, Soil Capability for Agriculture. This system, with its limitations, is used as a base with some modification, to estimate the potential productivity of the study area.

The annual productivity of wheat based on CLI ratings is 24 bushels per acre on Class 2 soil, falling to 9 bushels per acre on Class 5 soil. These yields are considerably lower than the yields based on Hail and Crop Insurance data. CLI figures are also lower than yields assumed in Alberta Agriculture (1982) Consensus studies for the Peace River Region. Yield figures used in the Consensus studies are 25 to 28 bushels wheat per acre on stubble and 35 bushels per acre on summer fallow. These estimates are given in Table 17.

The yield data provided by the Hail and Crop Insurance Corporation for Soil Class B are more in line with the yields used in costs and returns estimates by the Department of Agriculture. On the basis of Hail and Crop Insurance data for the Peace River Region, soils of the study area would be expected to yield crops which are from 8 percent to 30 percent below yields on similarly rated soils in the Calgary North Region. Yields equivalent to the provincial long term average should be obtained from the Class 3 soils, with proper management, while yields on Class 4 soils would be expected to be 15 to 20 percent lower than that average.

On the basis of productivity ratings, larger acreages are required in northern Alberta to generate sufficient revenue to cover costs and provide family income than would be required in southern and central Alberta. Also, because of relatively lower yields and thus

TABLE 16
SOIL PRODUCTIVITY RATINGS

General Description	CLI Agriculture Capability Class	Storie Rating System	Public Lands Division Basic Index	Ecological[1] Land Classification	Hail & Crop Insurance Ratings	Farmland Assessment Rating (%)
Crop Land	(1	7-8	60	High	A	79-100
	(2	6-7	41-60	Moderate	B	58-78
	(3	5-6	31-40	Low-High	C	41-57
	(4	4-5	24-30	Low-Moderate	D	28-40
Pasture	(5	3-4	16-23	Low-Low	E	16-27
	(6	2	5-15	Not Capable		
Non-Agricultural Land	(7	1	5			

[1] The evaluation classes correspond to slightly lower Basic Index values shown.

SOURCE: Alberta Institute of Pedology. "Soil Ratings in Alberta." The University of Alberta Bulletin. Edmonton, Alberta.

Alberta Agriculture (1981). "Farming Potential of the Jean D'Or Prairie Area: An Economic Assessment." Frank Hanus, Resource Economics, Edmonton, Alberta.

TABLE 17
YIELDS OF MAJOR CROPS

Crop		Soil Class Rating[1] B	C	D	E	Provincial Ave. Yield (1971-1980)	Wtd.Concensus Study Data
		(Bu/ac)					
Spring Wheat	Stubble	27.5	24.2	20.8	18.3	28.0	25
	Fallow	34.3	30.0	26.4	22.5		35
Barley	Stubble	35.8	32.5	28.3	24.2	42.6	40
	Fallow	48.3	42.5	37.5	32.5		
Canola	Stubble	14.2	12.5	10.8	9.2	18.6	15
	Fallow	20.0	17.5	15.8	13.3		25
Oats	Stubble	55.0	48.3	42.5	36.7	55.1	70
	Fallow	68.3	60.8	53.3	45.8		

Approximate Comparative CLI Class	2	3	4	5
CLI Producitivity of Wheat	24	18	14	9

SOURCE: 1. Farming Potential of the Jean D'Or Prairie Area: An Economic Assessment - based on 1981 Alberta Hail and Crop Insurance Corporation Information.

2. A Consensus of Costs and Returns, Peace River Region # 243 70/April/82, 244 70/April/82, and 249 76/April/82 Alberta Agriculture, Economic Services Division, Production Economics Branch.

lower gross revenue on Class 4 soils, farms established on these soils would be larger than those on Class 3 soils.

Hanus, (Alberta Agriculture, 1981) established viable farm unit sizes of 713 arable acres on lands rated "C" (approximately equivalent to CLI Class 3) and 1,017 arable acres on land rated "D" (approximately equivalent to CLI Class 4). For lands rated "B" (CLI Class 2) the viable size is 546 acres. These were determined on the basis of specific yields, capital investment costs, costs and return estimates, and living expense requirements of $18,000. No cash return on investment nor loan repayment were provided for in these calculations. Applying these estimates to the study area, the viable farm size would be in the vicinity of 800 acres per unit along the strip immediately east of Peace River, increasing to 900 to 1,000 acres per unit further east, where the soil is mainly Class 4.

Assumptions used in this study are:

1. Land Costs[1]	Mid September 1981 Price of Undeveloped Public Lands	Mid September 1982 1% Increase/Month
	($/acre)	
Class 2 (B)	70.00	78.40
Class 3 (C)	57.00	63.84
Class 4 (D)	45.00	50.40
Approximate Weighted Average for Study Area		60.70

2. Land Development Costs[2] by Different Methods	Single Disking or Disking x 2	No Disking or Disking x 1
	($/acre)	
Cutting, Piling and Plowing	205.00	195.00
Walking Down, Piling and Disking	185.00	175.00
Walking Down, Piling and Rotovating	215.00	205.00
Approximate Average	$200.00/acre	

3. Yields[3]

	Wheat		Barley		Canola		Oats	
Class	Stubble	Fallow	Stubble	Fallow	Stubble	Fallow	Stubble	Fallow
				(Bu/ac)				
2 (B)	27.5	34.3	35.8	48.3	14.2	20.0	55.0	68.3
3 (C)	24.2	30.0	32.5	42.5	12.5	17.5	48.3	60.8
4 (D)	20.8	26.4	28.3	37.5	10.8	15.8	42.5	53.3

4. Prices[4]

Wheat	$4.50 / bushel
Barley	$2.40 / bushel
Canola	$6.50 / bushel
Oats	$1.50 / bushel

5. Cropping Pattern

Wheat	25%	On Summerfallow	50%
		On Stubble	50%
Canola	25%	On Summerfallow	50%
		On Stubble	50%
Barley	12.5%		
Oats	12.5%		
Clover	25%		

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1. Taken from: Farming Potential of the Jean D'Or Prairie Area: An Economic Assessment.

2. Derived from: Land Clearing and Breaking Equipment Costs, Farm Business Management Branch, Alberta Agriculture, March 1981.

3. Derived from: Farming Potential of the Jean D'Or Prairie Area: An Economic Assessment

4. Taken from: A Consensus of Costs and Returns Peace River Region, Alberta Agriculture Economic Services Division, Production Economics Branch No. 243, 70, April 1982, No. 244 70 April, 1982, and No. 249 76 April, 1982.

Using the assumptions outlined above and costs taken from consensus studies, gross and net returns were calculated for various main crops. These are presented in Table 18. Average returns were determined using the crop mix specified previously and given in Table 19.

Revenue

Expected gross revenue per acre ranges from $82.50 for oats to $154.35 for wheat after clover fallow, and the average gross revenue is expected to be $83.60 per acre. Expected returns over cash costs range from $20.35 per acre for barley on stubble to $66.25 per acre of wheat on summerfallow. Based on the crop mix specified, the average return over cash costs is expected to be $28.41 per acre.

Costs

Cash costs include the direct costs of fertilizer, chemicals and machinery and equipment operation as well as the overhead costs of taxes, interest on operating costs, summerfallow costs (where applicable) and miscellaneous costs. The return over cash costs, or the contribution margin, is the income left to cover other non-cash costs. These costs are depreciation on equipment, machinery and buildings and unpaid labour costs.

Depreciation costs determined in consensus studies range from $22.23 per acre of wheat on stubble to $32.63 for canola on summerfallow and average $20.44 per acre for the crop mix specified. Net returns after depreciation thus average $7.97 per acre, ranging from ($4.50) per acre for barley to $35.17 per acre for wheat on clover summerfallow.

Capital loan repayments and interest are not included in cash or not-cash costs, these would have to be covered by the returns after depreciation as would returns to capital investment or interest opportunity costs.

TABLE 18

COSTS AND RETURNS ON CLASS 2 SOIL ($ PER ACRE)

	Wheat		Canola		Barley	Oats	Clover Fallow
	Stubble	Fallow	Stubble	Fallow			
Gross Returns							
bu / ac	27.5	34.3	14.2	20.0	35.8	55.0	--.-
$ / bu	4.50	4.50	6.50	6.50	2.40	1.50	--.--
$ / ac	123.75	154.35	92.30	130.00	85.92	82.50	--.--
Direct Cash Costs	62.64	62.64	60.30	60.30	55.12	46.89	9.62
Cash Overhead Costs	11.58	25.46	11.23	25.11	10.45	9.79	3.63
Total Cash Costs	74.22	88.10	71.53	85.41	65.57	56.68	13.25
Returns Over Cash Costs	49.53	66.25	20.77	44.59	20.35	25.82	(13.25)
Depreciation (Bldg. & Equip.)	22.23	31.08	23.78	32.63	24.85	28.94	8.85
Net Return	27.30	35.17	(3.01)	11.96	(4.50)	(3.12)	(22.10)

TABLE 19

WEIGHTED AVERAGE COSTS AND RETURNS[1] ($ PER ACRE)

Average Gross Return	83.60
Average Direct Cash Cost[2]	43.48
Average Cash Overhead Costs	11.71
Average Return over Cash Costs	28.41
Average Depreciation[3]	20.44
Average Net Return	7.97

1. Crop mix as specified in assumption 5.

2. Clover fallow cash costs included in cash overhead costs for wheat and canola grown on fallow.

3. Clover fallow depreciation costs included in depreciation costs for wheat and canola grown on fallow.

500 Acre Farm

A 500 acre farm on Class 2 soil (125 acres wheat, 125 acres canola, 125 acres barley and oats, and 125 acres summerfallow) would provide a return before depreciation equal to $14,205.00 per year and after depreciation $3,985.00 per year. On Class 3 soils, yields and gross returns would be approximately 12% lower than those of Class 2 while costs would be minimally reduced by about 2 to 3%, to reflect lower harvesting costs. Returns over cash costs fall to an average of $19.94 per acre reflecting a range of $11.52 per acre of canola on stubble to $49.21 for wheat on summerfallow. Returns after cash costs would be $9,975 for a 500 acre farm. This is insufficient to cover average depreciation costs and there is no return to labour or capital.

On Class 4 soils, where yields are about 22% below those of Class 2 and costs fall by 4 to 5%, returns over cash costs range from $2.26 per acre for canola on stubble to $34.95 for wheat on summerfallow, averaging $12.24 per acre for the crop mix specified. On a 500 acre farm returns over cash costs would be $6,120. Again, this is insufficient to cover depreciation costs, and returns to labour and capital are negative.

1000 Acre Farm

Assuming larger average farm sizes of 1000 acres, return after cash expenses would be $28,410 on Class 2 land, $19,950 on Class 3 land and $12,240 on Class 4 land. These estimates assume constant returns to sale (constant relationships between costs and returns). Depreciation costs of $20,440 for 1000 acres would be covered on a farm on Class 2 soil leaving a net return of $7,970 to labour and capital. Depreciation costs would not be covered on farms with lower soil capability and lower yields.

Sensitivity Analysis

This section examines the effect of changes in cost and return relationships on returns after cash costs and returns after depreciation.

I. Cost Variations

Assumptions

i) Constant yields and crop mix
ii) Constant Prices
iii) 10%, Changes in Costs

Returns at Different Cost Levels

Soil Class	2	3	4
		($ / ac)	
No Change in Costs			
Average Gross Return/Ac	83.60	73.67	64.66
Average Cash Costs	55.19	53.72	52.42
Returns over Cash Costs	28.41	19.95	12.24
Average Depreciation	20.44	20.44	20.44
Net Return after Depreciation	7.97	(0.49)	(8.2)
10% Reduction in Costs			
Average Cash Costs	49.67	48.35	47.18
Returns over Cash Costs	33.93	25.32	17.48
Average Depreciation	18.40	18.40	18.40
Net Return after Depreciation	15.53	6.92	(0.92)

Returns at Different Cost Levels (cont'd)

Soil Class	2	3	4
		($ / ac)	
10% Increase in Costs			
Average Cash Costs	60.71	59.09	57.[illegible]6
Returns over Cash Costs	22.89	14.58	7.00
Average Depreciation	22.48	22.48	22.48
Net Return after Depreciation	0.41	(7.9)	(15.48)
		($)	
Returns / 500 Ac.			
Over Cash Costs			
No Change in Costs	14,205	9,975	6,120
10% Reduction	16,965	12,660	8,740
10% Increase	11,445	7,290	3,500
		($)	
Returns / 500 Ac.			
After Depreciation	3,985	(245)	(4100)
No Change in Costs			
10% Reduction	7,765	3,460	(460)
10% Increase	205	(3950)	(7740)

Impact of Cost Reductions

Adjustments were made to costs to determine the impact of cost reductions on returns over cash costs and returns after depreciation costs. A 10% reduction in cash costs would result in an increase in returns over cash costs of $5.00 to $6.00 per acre or approximately $2,500 per 500 acres. A similar 10% reduction in depreciation costs would have the effect of increasing net returns after depreciation by about another $2.00 per acre.

With a 10% reduction in costs, returns over cash costs would be $16,965 on Class 2 soils, $12,660 on Class 3, and $8,740 on Class 4 per 500 acres. Returns after depreciation would be $7,765 on Class 2, $3,460 on Class 3, but would still be negative on Class 4 soils.

If costs were increased by 10%, the impact would be to reduce returns over cash costs on a 500 acre farm to $11,445 on Class 2, $7,290 on Class 3, and $3,500 on Class 4 soils. Returns after depreciation would decrease to $205 on Class 2, and would be negative on both Class 3 and Class 4 soils.

In effect, the net result of cost reductions would be to increase net returns after depreciation by approximately $1,666 for each 5% reduction in costs on a 500 acre farm. On Class 3 soils, a reduction as small as 1% in cash costs would enable depreciation costs to be covered, whereas for the same effect on Class 4 soils a reduction of 15% in cash costs would be needed.

On a 500 acre farm depreciation costs amount to approximately $10,000 per year. If the level of management assumed in the consensus of costs and returns studies is to be maintained under current economic conditions, it is apparent that farmers would live off of depreciation allowances and there would be no return to capital investment. Because of cash flow problems, farmers would cut back on inputs, such as fertilizers, to reduce costs. However, it is expected that this would have a negative impact on yields and therefore gross revenue. In the long run, returns over cash costs may be reduced and thus net returns to the family will also be reduced.

2. Price Variations

Assumptions

i) Constant yields and crop mix
ii) 10% Changes in Prices
iii) Constant Costs

Returns at Different Price Levels

Soil Class	2	3	4
		($ / ac)	
No Change in Prices			
Average Gross Return / Ac	83.60	73.67	64.66
Average Cash Costs	55.19	53.72	52.42
Return over Cash Costs	28.41	19.75	2.24
Average Depreciation	20.44	20.44	20.44
Net Return after Depreciation	7.97	(0.69)	(8.20)
10% Increase in Prices			
Average Gross Return / Ac	91.96	81.04	71.13
Average Cash Costs	55.19	53.72	52.42
Return over Cash Costs	36.77	27.32	18.71
Average Depreciation	20.44	20.44	20.44
Net Return after Depreciation	16.33	6.88	(1.74)
10% Decrease in Prices			
Average Gross Return / Ac	75.24	66.30	58.19
Average Cash Costs	55.19	53.72	52.42
Return over Cash Costs	20.05	12.58	5.77
Average Depreciation	20.44	20.44	20.44
Net Return after Depreciation	(0.39)	(7.86)	(14.67)
Returns / 500 Ac Over Cash Costs			
No Change in Price	14,205	9,875	6,120
10% Increase	18,385	13,660	9,355
10% Decrease	10,025	6,290	2,885

Returns at Different Price Levels (cont'd)

Soil Class	2	3	4
Returns / 500 Ac			
After Depreciation			
No Change in Price	3,985	(245)	(4100)
10% Increase	8,165	3,440	(870)
10% Decrease	(195)	(3930)	(7335)

Impact of Price Increases

The effect of price changes on returns after cash costs and depreciation is slightly greater than the effect of cost changes of similar magnitude. While a 10% reduction in cash costs results in increases in returns over cash costs of $5.00 to $6.00 per acre, a 10% increase in prices produces increases in returns over cash costs of $6.00 to $8.00 per acre. With a 10% increase in prices, returns over cash costs would be $18,385 for 500 acres on Class 2 soils and the net return after depreciation would be $8,165. With a 10% decrease in prices, returns after cash costs would be $10,025 for 500 acres and net returns would be negative.

3. Changes in Yields and Cropping Pattern

Assumptions

i) Higher proportion of barley and no oats (based on personal communications with District Agriculturist).

ii) Average yields for the Peace River Region (taken from Alberta Agriculture Statistics Yearbooks 1972 - 1986).

Prices	Wheat	4.50 / bushel	Yields	28.40 bu/ac
	Barley	2.40 / bushel		36.80 bu/ac
	Canola	6.50 / bushel		[illegible] bu/ac

Cropping Pattern

Wheat 20%	on summer fallow	50%
	on stubble	50%
Canola 20%	on summer fallow	50%
	on stubble	50%
Barley 40%		
Fallow 20%		

Returns at Lower Yields and Different Crop Mix

Costs and Returns	Wheat	Canola	Barley	Fallow
		(\$/acre)		
Gross Returns				
Bushel / acre	28.40	16.30	36.80	--.--
\$ / bushel	4.50	6.50	2.40	--.--
\$ / acre	127.80	105.95	88.32	--.--
Direct Cash Costs	62.64	60.30	55.12	9.62
Cash Overhead Costs	18.52	18.17	10.45	3.63
Total Cash Costs	81.16	78.47	65.57	13.25
Returns over Cash Costs	46.64	27.48	22.75	(13.25)

Weighted average return
over Cash Cost / acre 23.92
Per 500 acres 11,960.00

Returns at Lower Yields and Different Crop Mix (cont'd)

Costs and Returns	Wheat	Canola	Barley	Fallow
		($/ac)		
Depreciation (Build. & Equipment)	26.70	28.20	24.85	8.85
Net Return after Depreciation	19.94	(0.72)	(2.10)	(22.10)
Weighted average Net Return / acre		3.00		
Per 500 acres		1,500.00		

Cost Reduction and Price Increases (With Changes In Yields and Cropping)

Returns with Changes in Yields and Crop Mix, and Costs

	Wheat	Canola	Barley
		($/ac)	
No change in Costs and Prices			
Average gross return / ac	127.80	105.95	88.32
Average cash costs	81.16	78.47	65.57
Returns over cash costs	46.64	27.48	22.75
Weighted Average Return/ac		23.92	
Per 500 acres		11,960.00	
Average depreciation	26.70	28.20	24.85
Net return after depreciation	19.94	(0.72)	(2.10)
Weighted Average Net Return/ac		[illegible]	
Per 500 acres		1,500.0	

Returns with Changes in Yields and Crop Mix, and Costs (cont'd)

	Wheat	Canola	Barley
		($/ac)	
10% Reduction in Cost			
Average cash costs	73.04	70.62	59.01
Returns over cash costs	54.76	35.33	29.31
Weighted Average Return/ac	29.74		
Per 500 acres	14,870.00		
Average depreciation	24.03	25.38	22.37
Net return after depreciation	30.73	9.95	6.94
Weighted Average Net Return/ac	10.91		
Per 500 acres	5,455.00		
10% Increase in Costs			
Average cash costs	89.28	86.32	72.13
Returns over cash costs	38.52	19.63	16.19
Weighted Average Return/ac	18.09		
Per 500 acres	9,045.00		
Average depreciation	29.37	31.02	27.33
Net return after depreciation	9.15	(11.39)	(11.14)
Weighted Average Net Return/ac	(4.89)		
Per 500 acres	(2,445.00)		

Returns with Changes in Yields and Crop Mix, and Prices

	Wheat	Canola	Barley
		($/ac)	
10% Increase in Prices			
Average gross return / ac	140.58	116.55	97.15
Average cash costs	81.16	78.47	65.57
Returns over cash costs	59.42	38.08	31.58
Weighted Average Return/ac	32.13		
Per 500 acres	16,065.00		
Average depreciation	26.72	28.20	24.85
Net return after depreciation	32.72	9.88	6.73
Weighted Average Net Return/ac	11.21		
Per 500 acres	5,605.00		
10% Decrease in Prices			
Average gross return / ac	115.02	95.35	79.49
Returns over cash costs	33.86	16.88	13.92
Weighted Average Return/ac	15.70		
Per 500 acres	7,850.00		
Net return after depreciation	7.16	(11.32)	(10.93)
Weighted Average Net Return/ac	([illegible].20)		
Per 500 acres	[illegible]		

Impact of Crop Mix and Yield Modifications

The effects of varying the crop mix and yields from those used in the original assumptions (on Class 2 soil) are as follows:

i) Decrease in the weighted average return over cash costs from $28.41 to $23.92 per acre;

ii) Decrease in the weighted average return after depreciation from $7.97 to $3.00 per acre;

iii) A $2,305 reduction in returns over cash costs to $11,960 for a 500 acre farm;

iv) A $2,485 reduction in net returns after depreciation to $1,500 for a 500 acre farm.

Impact or Cost and Price Changes

i) A 10% reduction in costs restores returns to just above the values based on the original assumptions, while a 10% increase in costs reduces returns over cash costs to $9,045.00 or 50% of the value based on the original assumptions and results in negative net returns.

ii) Price changes of 10% have a slightly greater effect on returns after cash costs and net returns than do 10% changes in costs, a 10% increase in prices produces net returns of $5,605 compared with $5,455 for a 10% reduction in costs, a 10% decrease in prices reduces returns after cash costs to $7,850 compared with $9,045 for a 10% increase in costs.

Based on the original yield, cost and price assumptions, the expected return over cash costs from a 500 acre farm would be $14,205 per annum. A 10% increase in costs would result in a return of $11,445, while a 10% reduction in prices or yields would result in a return of $10,025. Using average provincial yields and a lower proportion of wheat and canola, the return over cash costs falls to $11,960. A combination of lower yields and either 10% higher costs or 10% lower prices would result in a further reduction in returns over cash cost to $9,045 and $7,850 respectively.

Cost reductions of 10% would increase returns over cash costs to $16,965, while price or yield increases of 10% would increase returns over cash costs to $18,385. The increases would be more moderate when average provincial yields and a higher proportion of barley are substituted, the results would be $14,870 for a 10% cost reduction and $16,065 for a 10% price increase.

These results are summarized in Table 20. Some analysis of the grain and oilseed market conditions is presented in Appendix II.

TABLE 20

AVERAGE ANNUAL RETURNS OVER CASH COSTS AND AFTER DEPRECIATION

	Average Return Over Cash Costs	Average Return After Depreciation
	$/500 acres	
Original Assumptions	14,205	3,985
10% Cost Reduction	16,965	7,765
10% Cost Increase	11,445	205
10% Price Increase	18,385	8,165
10% Price Reduction	10,025	(195)
40% Barley, Prov. Yields	11,960	1,500
10% Cost Reduction	14,870	5,455
10% Cost Increase	9,045	(2,445)
10% Price Increase	16,065	5,605
10% Price Reduction	7,850	(2,600)

4.3 PROJECT ANALYSIS

This section examines the proposed farm settlement on an aggregate level to determine whether it is economically justifiable. The analytic tool used is present value analysis. Further the project is examined in more general terms to determine whether it is socially justifiable.

Project costs and returns are summarized as follows:

1.	Infrastructure Costs	$	
	Roads (Alternate B)	50,060,000	
	Power	4,062,000	
	Sub-Total (I)		54,122,000
	Bridge	17,000,000	
	Sub-Total (II)		71,122,000
2.	Cost of Land (250,000 acres)		
	Purchase	15,175,000	
	Clearing & Breaking	50,000,000	
	Sub-Total (III)		65,175,000
	Total (excluding bridge)		119,297,000
	(including bridge)		136,297,000
3.	Gross Revenue/Annum	20,900,000	
4.	Cash Farm Expenses	13,797,000	
5.	Returns After Cash Costs	7,102,500	
6.	Depreciation	5,110,000	
7.	Net Return After Depreciation	1,992,500	

Thus for an initial capital outlay of 120 to 136 million dollars there is an expected gross revenue stream of 20.9 million dollars per annum. The annual net cash inflow, after covering all cash expenses, is 7.1 million dollars. On the basis of this net cash inflow the pay-back period of the project would be 17 to 19 years.

The net present benefit or cost to the farmers was determined using the following assumptions:

1. A project life of 25 years.
2. Discount rates of 5%, 10% and 15%.
3. Phasing in the project over a) 3 years, b) 5 years, and c) 10 years.
4. No output in the first year and output increasing proportionately from the second year to a) the third, b) the fifth, and c) the tenth year.
5. Farmers' capital expenditure represented by land purchase, clearing and breaking costs, and 50% of power costs.
6. Farms' net cash inflow represented by returns after cash costs.
7. Capital expenditure phased in in equal proportions over a) 3 years, b) 5 years, and c) 10 years.

It should be noted that the cash inflow used in the analysis is based on the crop mix assumed previously. However, during establishment there would be up to 60 or 80 percent canola seeded. The percentages of wheat and barley would be quite low. The net return of canola is lower than that of wheat, however, the effect of this on average returns after cash costs is offset by the effect of a lower percentage of barley in the mix. A combination of 70 percent canola, and 10 percent each of wheat, barley and clover fallow would produce an average net return after cash costs of $29.37 per acre. This is not signicantly different ($0.96 higher) than the figure used in the original analysis.

Also, it is likely that there would be a higher percentage of barley produced and little or no oats. Replacing oats completely with barley has the effect of reducing the average net return after cash costs by $3.99 per acre to $24.42 per acre.

The results of the discounting analysis are given in Tables 21 to 23.[1] Where the project is phased in over three years, the discounted value of the net inflow stream is less than that of the farmers' capital outflow at both 10 percent and 15 percent discount rates. However, at a 5 percent discount rate, there is a positive net benefit to the farmers of 22.1 million dollars.

Assuming a phasing-in period of five years, again the net benefit to farmers is negative at both 10 percent and 15 percent rates but these net values are somewhat lower, due to the more gradual phasing-in of capital expenditure. At a 5 percent discount rate, the net benefit to farmers is again positive and equal to 19.5 million dollars. With a 10 year phasing-in period, the net benefit to farmers at a 5 percent discount rate falls to 18.5 million dollars. At higher discount rates, the net benefits are again negative.

Thus at discount rates of 10 percent or higher it is not economically feasible for farmers to make capital investments of the magnitude necessary for establishing 500 acre farms in the study area. This applies to whether farms are phased in over three years, five years, or ten years.

At lower discount rates, specifically 5 percent, it does become feasible for farmers to make this investment, from a long term economic view point. Phasing in over three years requires large capital expenditure at the start of the project, equivalent to $44,804 per farmer for each of the first three years. It also requires considerable effort on the part of each farmer to get the total 500 acres cleared, tilled and seeded in a relatively short time. However, it implies maximum revenue inflows from the fourth year and thus a somewhat better net present value at a level which is 13 percent higher than that for phasing-in over five years.

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[1] "Discounting" is the process of finding the present worth or the value today of a future cost, income or income stream. The rate assumed for discounting is the "discount rate" and it reflects a time preference for money or the opportunity cost of money.

TABLE 21

NET PRESENT VALUE ANALYSIS

PEACE RIVER AGRICULTURAL PROJECT

(250,000 ACRES PHASED IN OVER 3 YEARS)

	Discount Rate	Years				Total Discounted Value
		1	2	3	4 - 25	
				($'000)		
Gross Cash Inflow		-	6,966	13,932	20,900	
Operating Cash Outflow		-	4,599	9,198	13,797	
Net Cash Inflow		-	2,367	4,734	7,102	
Discounted Net Cash Inflow	5%	-	2,147	4,089	76,909	83,145
	10%	-	1,956	3,557	42,550	48,063
	15%	-	1,790	3,113	25,819	30,722
Farmers' Capital Cash Outflow						
Land Purchase 15,175		5,058	5,058	5,058	-	
Clear & Break 50,000		16,667	16,667	16,667	-	
Power(50%) 2,032		677	677	677	-	
Total Farmers' Capital Outflow 67,207		22,402	22,402	22,402	-	
Discounted Capital Outflow	5%					61,000
	10%					55,714
	15%					51,144
Net Benefit (or Cost) To Farmers		(22,402)	(20,035)	(17,668)	7,102	
Discounted Net Value To Farmers	5%					22,145
	10%					(7,651)
	15%					(20,422)

TABLE 21 (Cont.)
NET PRESENT VALUE ANALYSIS
PEACE RIVER AGRICULTURAL PROJECT
(250,000 ACRES PHASED IN OVER 3 YEARS)

	Discount Rate	Years 1	2	3	4 - 25	Total Discounted Value
				('000)		
Public Costs:						
Roads 50,060		16,687	16,687	16,687	-	
Power (50%) 2,032		677	677	677	-	
Total Roads & Power 52,092		17,364	17,364	17,365	-	
Bridge 17,000		5,666	5,666	5,666	-	
Roads, Power & Bridge Total 69,092		23,030	23,030	23,030	-	
Discounted	5%					62,710
Capital	10%					57,275
Outflow	15%					52,577
Net Benefit or Cost To Farmers & Public		(45,432)	(63,100)	(40,698)	7,102	
Discounted Net	5%					(40,565)
Value to Farmers	10%					(64,926)
& Public	15%					(72,999)

Assumptions:

1. Land clearing and tilling operations are phased in over 3 years.
2. Road construction and power supply are phased in over 3 years.
3. Bridge construction spans 3 years.
4. Production is phased in from the second year, full production is achieved in the fourth year.
5. The project life is 25 years.

TABLE 22
NET PRESENT VALUE ANALYSIS
PEACE RIVER AGRICULTURAL PROJECT
(250,000 ACRES PHASED IN OVER 5 YEARS)

	Discount Rate	1	2	Years 3	4	5	6 - 25	Total Discounted Value
					('000)			
Gross Cash Inflow		-	4,180	8,360	12,540	16,720	20,900	
Operating Cash Outflow		-	2,759	5,518	8,277	11,036	13,797	
Net Cash Inflow		-	1,420	2,840	4,260	5,680	7,102	
Discounted Net Cash Inflow	5%	-	1,288	2,453	3,505	4,450	66,043	77,739
	10%	-	1,173	2,134	2,910	3,577	34,133	43,877
	15%	-	1,074	1,867	2,436	2,824	19,216	27,417
Farmers' Capital Cash Outflow								
Land Purchase 15,175		3,035	3,035	3,035	3,035	3,035	-	
Clearing & Breaking 50,000		10,000	10,000	10,000	10,000	10,000	-	
Power Costs (50%) 2,032		406	406	406	406	406	-	
Total Farmers' Capital Outflow 67,207		13,441	13,441	13,441	13,441	13,441	-	
Discounted Capital Value to Farmers	5%							58,186
	10%							50,955
	15%							45,054
Net Benefit (or Cost) To Farmers		(13,441)	(12,021)	(10,601)	(9,181)	(7,761)	7,102	
Discounted Net Value to Farmers	5%							19,553
	10%							(7,078)
	15%							(17,637)

TABLE 22 (Cont.)
NET PRESENT VALUE ANALYSIS
PEACE RIVER AGRICULTURAL PROJECT
(250,000 ACRES PHASED IN OVER 5 YEARS)

	Discount Rate	Years 1	2	3	4	5	6 - 25	Total Discounted Value
				($'000)				
Public Costs:								
Roads 50,060		10,012	10,012	10,012	10,012	10.012	-	
Power(50%) 2,032		406	406	406	406	406	-	
Total 52,092		10,418	10,418	10,418	10,418	10,418	-	
Bridge 17,000		5,666	5,666	5,666	-	-	-	
Roads, Power & Bridge Total 69,092		16,084	16,084	16,084	10,418	10,418	-	
Discounted Capital Outflow	5% 10% 15%							60,527 53,586 47,856
Net Benefit or Cost To Farmer & Public		(29,525)	(28,105)	(26,685)	(19,599)	(18,179)	7,102	
Discounted Net Value to Farmers & Public	5% 10% 15%							(40,974) (60,664) (65,493)

Assumptions:

1. Land clearing and tilling operations are phased in over 5 years.
2. Road construction and power supply are phased in over 5 years.
3. Bridge construction spans 3 years.
4. Production is phased in from the second year; full production achieved in the sixth year.
5. The project life is 25 years.

TABLE 23
NET PRESENT VALUE ANALYSIS
PEACE RIVER AGRICULTURAL PROJECT
(250,000 ACRES PHASED IN OVER 10 YEARS)

	Discount Rate	1	2	3	4	5	Years 6	7 ($'000)	8	9	10	11 - 25	Total Discounted Value
Gross Cash Inflow		-	4,180	6,270	8,360	10,450	12,540	14,630	16,720	18,810	20,900	20,900	
Operating Cash Outflow		-	2,759	4,139	5,519	6,898	8,278	9,658	11,038	12,417	13,797	13,799	
Net Cash Inflow		-	1,421	2,131	2,841	3,552	4,262	4,972	5,682	6,393	7,103	7,103	
Discounted Net Cash Inflow	5%	-	1,288	1,841	2,337	2,782	3,180	3,534	3,846	4,123	4,360	41,099	76,398
	10%	-	1,174	1,601	1,940	2,205	2,406	2,552	2,651	2,711	2,738	18,946	38,924
	15%		1,074	1,401	1,679	1,766	1,842	1,869	1,857	1,812	1,756	8,927	23,932
Farmers Capital Cash Outflow Land Purchase 15,175		1,517	1,517	1,517	1,517	1,517	1,517	1,517	1,517	1,517	1,517	-	
Clear & Break 50,000		5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	5,000	-	
Power (50%) 2,032		203	203	203	203	203	204	203	203	203	203	-	
Total Farmers Capital Outflow		6,721	6,721	6,721	6,721	6,721	6,721	6,721	6,722	6,721	6,721	-	
Discounted Capital Outflow	5%												51,897
	10%												41,296
	15%												33,731
Net Benefit/Cost To Farmers		(6,721)	(5,300)	(4,590)	(3,880)	(3,170)	(2,459)	(1,749)	(1,039)	(328)	382	7103	

TABLE 23 (Cont.)
NET PRESENT VALUE ANALYSIS
PEACE RIVER AGRICULTURAL PROJECT
(250,000 ACRES PHASED IN OVER 10 YEARS)

	Discount Rate	1	2	3	4	5	6	7	8	9	10	11 - 25	Total Discount Value
						Years ($'000)							
Discounted Net Value To Farmers	5%												18,501
	10%												(2,385)
	15%												(9,799)
Public Costs Roads 50,060		5,006	5,006	5,006	5,006	5,006	5,006	5,006	5,006	5,006	5,006	-	
Power (50%) 2,032		203	203	203	203	203	203	203	203	203	203	-	
Bridge 17,000		1,700	1,700	1,700	1,700	1,700	1,700	1,700	1,700	1,700	1700	-	
Total 69,092		6,909	6,909	6,909	6,909	6,909	6,909	6,909	6,909	6,909	6,909	-	
Discounted Capital Outflow	5%												53,351
	10%												42,456
	15%												34,676
Net Benefit or Cost To Farmer & Public		(13,630)	(12,209)	(11,499)	(10,789)	(10,079)	(9.368)	(8,658)	(7,948)	(7,229)	(6,527)	7103	
Discounted Net Value To Farmers & Public	5%												(34,850)
	10%												(44,841)
	15%												(44,475)

Phasing in the project over 5 years would be more practical and perhaps more attainable. Capital expenditure per farmer would be $26,882 per annum for the first five years, and land clearing and breaking would be more gradual - 100 acres per year instead of 166 acres per year. What is more likely is phasing in over a longer period of up to 10 years, especially for farms over 500 acres in size. This is in keeping with current financing methods and with the usual system of part-time farming which occurs during farm development. The farmer's annual capital outflow would be $13,454.

Extending the analysis to include public capital expenditure on infrastructure presents a different economic picture. The present value of providing infrastructure is in the region of 35 to 60 million dollars, considerably greater than the net present value of the entire project to the farmers.

To provide roads and power (50%) over a three year period the discounted value of total capital expenditure is 45 million dollars, at a discount rate of 5 percent. This value falls to 35 million at 15 percent. With phasing in over five years, the values are 47 million at 5 percent and 40 million at 15 percent. These values fall to 53 million at 5 percent and 35 million at 15 percent, with phasing in over 10 years.

In the final analysis, the total net cost of the project to society would be within a range of 35 to 73 million dollars, in present value terms. This range represents various discount rates and phasing in periods. Obviously, the higher the discount rate the higher the present value of the net cost. Also in this particular instance, the faster phasing in rate is associated with a higher net present cost, at higher discount rates. At a 5 percent discount rate, three year or five year phasing in periods are equally favourable. A 10 year phasing in period reduces the net present cost of the project by 5 million dollars.

Sensitivity Analysis

Changes in costs, prices, yields and crop mix discussed previously would have an impact on the net present value of the project. Reductions in returns over cash costs could result from cost increases, price reductions, or lower returns due to lower yields and a higher proportion of low-valued barley in the crop mix.

These reductions range from 16 percent to 29 percent for the changes examined. With a higher barley proportion and using provincial yields, the net cash inflow falls by 16 percent. A 10 percent increase in costs or a 10 percent decrease in prices would cause 19 percent and 29 percent decreases in the net cash inflow respectively. Equivalent percentage reductions occur in the net present value of the net cash inflow.

A 15 percent reduction in the return over cash costs would reduce the farmers' discounted net cash inflow, and therefore net benefit by 10 to 12 million dollars (at a 5 percent discount rate). The net benefit to farmers would fall to 8 to 10 million dollars and the net cost of the project would increase by 10 to 12 million dollars.

With a 20 percent reduction in the returns over cash costs the discounted values would change by 14 to 17 million dollars. Finally, a 30 percent reduction would cause a 21 to 24 million dollar change in the discounted values, and the net benefits to farmers would be negative. These results are given in Table 24.

Changes in capital costs would also have an impact on the net present value of the project. If 1000 acre farms are established instead of 500 acre farms, there would be a reduction in the total capital cost of 20.75 million dollars. This represents a 30 percent reduction in the total capital outflow. The capital cost to farmers would be reduced by $375,000 (50 % of the power cost reduction), and this would increase the discounted net benefit to farmers. At a five percent discount rate this increase would be [illegible] [illegible]0,000, or less than one percent.

TABLE 24
NET PRESENT VALUE SENSITIVITY ANALYSIS
(5 PERCENT DISCOUNT RATE)

	Phasing - In Period		
	3 Years	5 Years	10 Years
Original Estimates		($ Million)	
Discounted Value to Farmers	22.1	19.5	18.5
Discounted Public Capital Outflow	62.7	60.5	53.3
Discounted Value to Farmers & Public	(40.5)	(40.9)	(34.8)
15% Reduction in Net Cash Inflow		(Higher % Barley and Lower Yields)	
Discounted Value To Farmers	9.7	7.9	8.0
Discounted Value To Farmers & Public	(52.9)	(52.5)	(45.3)
20% Reduction in Net Cash Inflow		(10% Increase in Costs)	
Discounted Value to Farmers	5.5	4.0	4.5
Discounted Value to Farmers & Public	(57.0)	(56.3)	(48.8)
30% Reduction in Net Cash Inflow		(10% Decrease in Prices)	
Discounted Value to Farmers	(2.8)	(3.7)	(2.5)
Discounted Value to Farmers & Public	(65.3)	(64.0)	(55.8)
30% Reduction in Capital Costs	(Larger Farms of 1000 Acres Each)		
Discounted Value to Public Capital Costs	44.2	42.2	37.6
Discounted Value to Farmers & Public	(22.0)	(23.0)	(19.1)

The reduction in capital cost to the public of $20,375,000 would have a more significant impact. This 29.5 percent reduction in the capital cost to the public would produce a reduction of 15 to 18 million dollars in terms of the net present value of the public cost. The discounted net cost of the project would fall by the same amount to between 19 million and 23 million dollars, at a 5 percent discount rate, depending on the length of the phasing in period.

Analysis of the project, based on the framework of partial economic analysis, indicates that the investment is not feasible for society. This is because the immediate income or revenue benefits resulting from agricultural production are not adequate to cover the capital expenditure on infrastructure, except at a discount rate of 1 percent. However, there are a number of secondary and tertiary benefits and costs of such an investment and these should be considered within the decision-making process. Some of these considerations are shown diagramatically in Figure 2.

Multiplier Effect of the Project

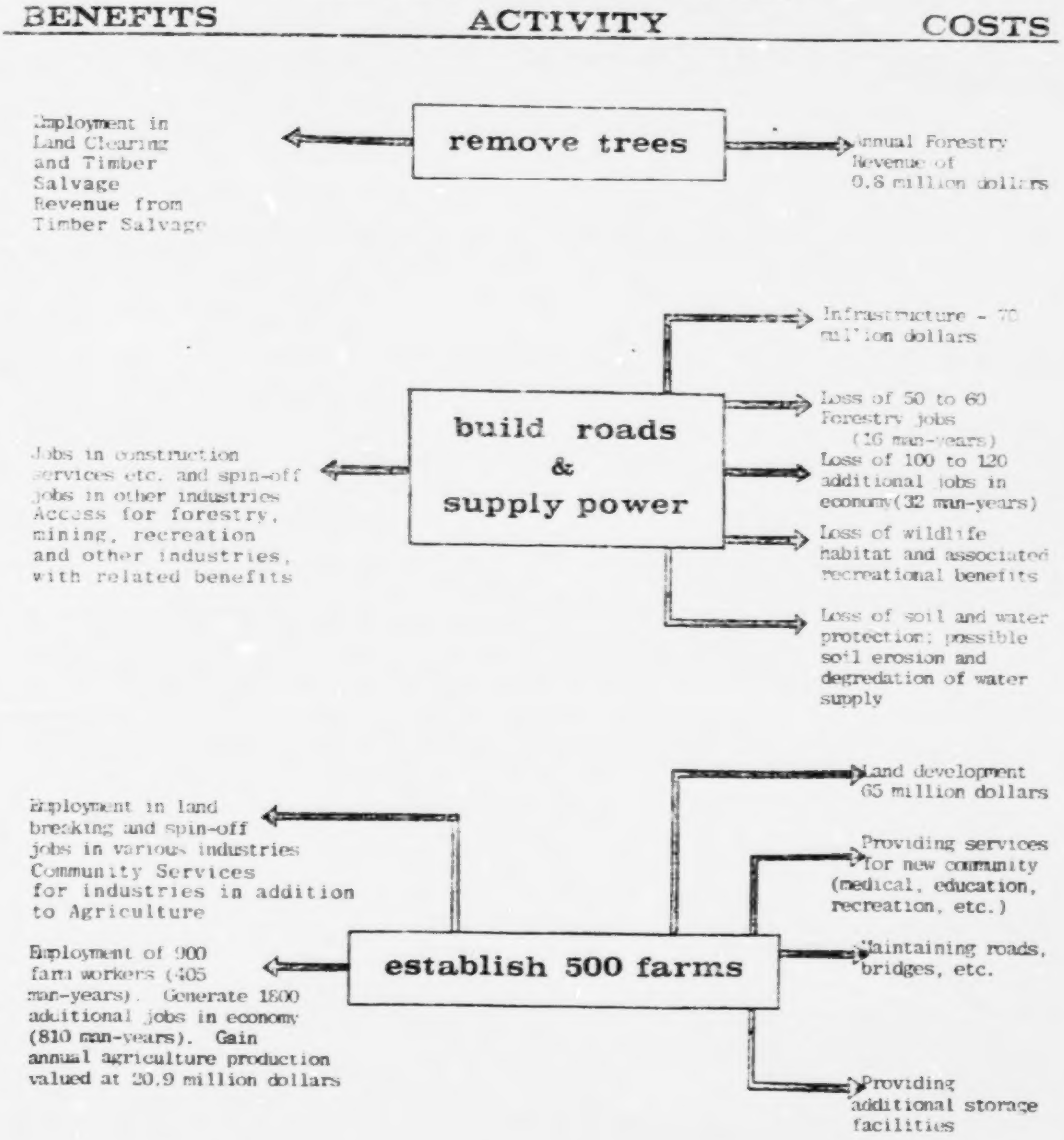
There would be a short-run or immediate impact of the project during development. This would include the actual direct and indirect employment created during land development, road and bridge construction and power installation. The direct or basic farm employment resulting from the project is a primary benefit. Settlement of 500 farms would provide employment for 500 families composed on the average of 500 operators and 200 other family members. This is based on 56 percent of the farm labour force being operators and 22 percent other family members. There would be approximately 200 jobs for hired labour, 22 percent of farm labour being hired.

Employment would be supplied for 5 to 6 months per year and therefore the project would generate approximately 315 man years of employment for the farm families and another 90 man years for hired workers. Increasing farm size to 1000 acres would reduce the number of farms to 250 and thus reduce the employment impact by 50 percent.

Figure 2

PROPOSED CADOTTE, PEACE RIVER AGRICULTURAL PROJECT:

CHART SHOWING SOME BENEFITS AND COSTS


BENEFITS
ACTIVITY
COSTS
Employment in Land Clearing and Timber Salvage Revenue from Timber Salvage
remove trees
Annual Forestry Revenue of 0.8 million dollars
Jobs in construction services etc. and spin-off jobs in other industries Access for forestry, mining, recreation and other industries, with related benefits
build roads & supply power
Infrastructure - 70 million dollars
Loss of 50 to 60 Forestry jobs (16 man-years)
Loss of 100 to 120 additional jobs in economy(32 man-years)
Loss of wildlife habitat and associated recreational benefits
Loss of soil and water protection; possible soil erosion and degredation of water supply
Employment in land breaking and spin-off jobs in various industries Community Services for industries in addition to Agriculture
Employment of 900 farm workers (405 man-years). Generate 1800 additional jobs in economy (810 man-years). Gain annual agriculture production valued at 20.9 million dollars
establish 500 farms
Land development 65 million dollars
Providing services for new community (medical, education, recreation, etc.)
Maintaining roads, bridges, etc.
Providing additional storage facilities

Based on a multiplier of 2.0, these basic farm jobs would generate 1,800 non-basic jobs elsewhere in the economy. These would be equivalent to 810 man years. Where a high proportion of migrant labour is employed the multiplier effect would be greater. The non-basic jobs created would be distributed amongst a number of other industries including other primary industries; manufacturing, transportation, communication and other utilities, trade, finance, insurance and real estate, service and public administration. Again the indirect impact on employment would be reduced if 250 farms are established instead of 500 farms.

Some of the spin-off activities are briefly indicated for specific industries. The farming activity would create a demand for farm machinery, vehicles and equipment. This would have an effect on mining, manufacturing, trade and service of these items. The effect would be felt both in the local community, specifically at the sales and service level, and elsewhere in the economy in the manufacturing and trade of both the major items and parts. The demand for fertilizer and other chemicals would produce a similar effect in the chemical and the fuel industries at the levels of mining, manufacturing and trade.

Another major spin-off effect would be in the areas of marketing, storage and processing of the agricultural commodities produced. Thus there would be an impact in the transportation, manufacturing (food and beverage) and trade industries. The demand for machinery and chemical inputs would also create an impact on the transportation industry.

All of these activities, both at the farm level and in the industries affected, would create additional economic activity and jobs in the areas such as finance, public administration and services. Specific activities would be in providing farm credit, legal and other advice, accommodation, recreation, and administration of leases and related procedures.

Finally, the construction of a bridge across the Peace and the provision of access to areas east of the river, would not service only the new agricultural community but a number of other industries. These include forestry, mining, both fuel and non-fuel minerals, recreation and hunting. In fact, it would be fair to distribute the cost of the infrastructure between the industries that would be serviced, thus reducing the infrastructure capital cost charged to the agricultural project.

Discount Rate and Time Preference

For benefit-cost ratios or net present worth calculations, the most appropriate rate is the opportunity cost of capital. There are practical problems of establishing this rate. In practice the rate chosen is often a rule of thumb: 12 percent seems to be a popular choice and almost all countries seem to think it lies somewhere between 8 percent and 15 percent.

Some literature suggests that the discount rate attached to future returns by the society as a whole is different from that which individuals would use. Normally, it is felt that the society has a longer time horizon, so that its discount rate would be lower. Rates in the vicinity of 4 to 8 percent have been used in investment analysis for agricultural projects.

One way of dealing with this problem is to present analysis at different discount rates, another is to establish the actual internal rate of return (I.R.R.) and thus avoid selecting a discount rate. These various measures can then be used together for ranking a number of projects and to indicate the discount rate at which each project would be economically feasible.

Benefit - cost ratios (B/C) and internal rate of return values (I.R.R.) were calculated for the project. These are as follows:

B/C

Discount Rate	Net Cash Inflow / Farmers' Capital Cost			Net Cash Inflow / Total Capital Cost		
	3 yrs	5 yrs	10 yrs	3 yrs	5 yrs	10yrs
5%	1.36	1.34	1.36	0.67	0.65	0.67
10%	0.86	0.86	0.94	0.42	0.42	0.46
15%	0.60	0.61	0.71	0.29	0.29	0.35

I.R.R. (To farmers only)

I.R.R. (3 Years)

$$= 5 + 5\left(\frac{22,145}{29,796}\right) = 5 + 5\,(0.74)$$

$$= 5 + 3.72 = 8\%$$

I.R.R. (5 Years)

$$= 5 + 5\left(\frac{19,553}{26,631}\right) = 5 + 5\,(0.73)$$

$$= 5 + 3.67 = 8\%$$

I.R.R. (10 Years)

$$= 5 + 5\left(\frac{18,501}{20,886}\right) = 5 + 5\,(0.88)$$

$$= 5 + 4.40 = 9\%$$

(To Society)

I.R.R. (3 Years)

$$= 0 + 1\left(\frac{7,014}{19,175}\right) = 0 + 1\,(0.36)$$

$$= 0 + 0.36 = < 1\%$$

I.R.R. (5 Years)

$$= 1 + 1\left(\frac{1,913}{14,473}\right) = 1 + 1\,(0.13)$$

$$= 1 + 0.13 = 1\%$$

$$\text{I.R.R. (10 Years)} = 0 + 1\left(\frac{8{,}592}{13{,}677}\right) = 0 + 1\ (0.62)$$

$$= 0 + 0.62 = <1\%$$

As previously indicated by the net present value analysis, it would not be feasible for farmers to invest at discount rates of 10 percent or higher - the B/C ratio is less than 1 at these rates. From the farmers point of view the I.R.R. is 8 to 9 percent, depending on the rate of capital expenditure. This indicates that if a farmer's time preference rate is at or below 8 percent the decision will be made to invest. For society as a whole the B/C is below 1 at each discount rate used, and the I.R.R. is 1 percent or less. The decision to invest will have to be made on the basis on other benefits and not the direct economic benefits of the project.

Possible Constraints and Other Considerations

Because of distances involved and the location and availability of road building materials, infrastructure costs may be above the estimates provided. Another factor to be considered is grain handling, the existing grain elevators may not be adequate and expansion may be necessary.

If the ferry option is followed then transportation of grain will be limited to a few months, implying additional storage required at Manning or on the farm. This would be partly offset by the use of ice bridges to haul grain in winter. If a bridge is constructed, access will have to be via the south during the three years needed for bridge construction.

Part of the study area is already being reforested, this would have to be taken into account in the planning of the project. Specific access routes have to be determined, taking into consideration the location of the Three Creeks Grazing Reserve and the existence of a number of water courses.

Adequate measures have to be taken to limit the negative effect of clearing, breaking and drainage on soil and water conservation, flooding and other water related problems.

A cost not examined in the project analysis is that of providing for the social needs of the farm settlement. These include education, health, recreation and utilities.

Finally, the study has not examined the financing of the project. For a project of this size, specific financing methods will have to be determined and planned. Financial arrangements will modify the partial analysis done for the project. Traditionally, financing has come from four major sources. These are existing wealth brought in by migrant farmers; profits from existing farm operations; off-farm income; and credit. The first source is somewhat limited in extent, but facilitates fairly rapid development. Some combination of the other three sources is the norm, and this permits only gradual development.

5. SUMMARY AND CONCLUSIONS

5.1 Relative Importance of Forestry and Agriculture

On a national scale, forests occupy one third of the land area, totalling 3.26 million km^2. Of the total land area of the ten provinces (5.4 million km^2), over half (2.9 million km^2) is under forests, compared with 400,000 km^2 of improved farm land. Forest products shipped in 1979 were valued at $26.1 billion, compared with total farm cash receipts of $14.3 billion. However, agriculture is the larger employer, providing jobs for 693,500 persons in 1979 while forestry employed 304,000 in the same year. Forestry leads in trade, with exports valued at $12.09 billion in 1980 and contributing $11.70 billion to the balance of trade. Agriculture's exports were $6.59 billion with the food sector contributing $3.61 billion to the balance of trade in 1980.

At the provincial level, while forest lands occupy 388,000 km^2 and improved farm land 112,000 km^2, Alberta's agriculture sector is of greater significance economically. The value of forest products shipped in 1979/80 was $239 million and farm cash receipts totalled $3,132 million. Agriculture ranks first in employment among primary industries, providing 83,000 jobs and forestry ranks third providing 10,000 jobs in 1979/1980. Agriculture's contribution to Alberta's gross domestic product (at factor cost) was $1,751 million, or 5.4 percent of the total 1979 G.D.P. Forestry's contribution was relatively small, $44 million, representing only 0.1 percent of G.D.P.

In the manufacturing industries, the food and beverage industries contributed 30.5 percent or $3,241 million to the total value of shipments in 1980. The wood products industries and paper and allied products industries together contributed $776 million or made up 7.3 percent of the value of manufactured products. The food and beverage industry employed 16,118 workers in 1979, the wood products industries 6,571 employees and the paper and allied products industries 2,338.

Under current economic conditions, both the forestry and agricultural industries are experiencing high costs relative to product prices. Sawmill operators in the Peace River region reported losses of up to $26.00 per thousand board feet in the last timber year. Across Canada, the wood products industries are operating at levels of 70 to 80% of capacity. Curtailments and layoffs are prevalent and Canadian producers are threatened by U.S. protectionism, and by price pressure on the European market.

On the basis of consensus cost estimates and average yield in the Peace River region, net returns to agriculture are minimal under current price regimes. Canada's grain exports continued to increase into 1982. However, current world stocks and surplus production are creating downward pressure on prices. The oilseed market is in a slump, Canadian exports of canola dropped in 1979/80 and 1980/81. However, oilseed prices increased slightly in 1981/82 and moderate price increases are expected for the current crop year.

5.2 Foresty Potential in the Study Area

The study area falls within Alberta Forestry's "Maintaining our Forests Program", the aim of which is to convert areas currently under poplar and spruce stands, to form lumber industry reserves. Blocks within two townships in the area were cleared during 1980 - 81 and planting was started last fall. The department is undertaking a situation appraisal of the Peace River region to determine planning priorities. Extensive inventory work would be necessary to establish the potential forest productivity of the study area, which forms part of Forestry Management units P4 and P5.

Currently, quotas for approximately 73 percent of the annual allowable cut of coniferous trees in P4 are held by two producers. The net annual allowable cut is 56,435 m^3 (11 million board feet) of which 40,946 m^3 (8 million board feet) form the authorized annual quota cut. Additional timber is harvested through permits and salvage.

The net annual allowable cut for management unit P5 is below that of P4, being approximately 7 million board feet. However, P5 is far less accessible and the companies working in the area have no immediate interest in moving into P5.

Given the right market conditions, it is conceivable that harvesting could be extended to its full potential in P4 and P5 and current activity could be doubled. Approximately 50 percent of the current harvest in P4 falls within the study area and it can be assumed that this pattern would continue, due to the relatively easier access to the study area than to more distant parts of P4 and P5.

Employment in logging would be increased from the current level of 30 to 35 people, to 60 to 70 people (including company employees and permit holders), for 3 - 4 months per year. Assuming that all the labour employed is local, and using a local labour multiplier of 1.71, this increase of 30 to 35 basic jobs would result in an additional increase of 21 to 25 non-basic jobs. If labour is brought in from outside the area, the multiplier would be closer to 2.0 and the number of non-basic jobs created would be equivalent to the number of new basic jobs created in logging.

Additional basic jobs would also be created in the sawmilling operation, amounting to approximately 20 to 25 new jobs. These in turn would have the effect of creating an additional 14 to 18 jobs elsewhere in the economy, where sawmilling jobs were filled by local labour. If sawmilling jobs were filled by migrant labour or a mixture of migrant and local labour, the multiplier effect would be greater and would create 20 to 25 jobs elsewhere in the economy.

Summarizing:

Number of Basic Jobs Created by Doubling Activity		Number of Non-Basic Jobs Created Where New Jobs Filled by:	
		Local Labour	Migrant Labour
1. Logging:	30 - 35	21 - 25	30 - 35
2. Sawmilling:	20 - 25	14 - 18	20 - 25
TOTAL New Jobs Created (Basic and Non-Basic)		85 - 103	100 - 120

The net effect of doubling the forestry activity in the study area would be to create 85 to 120 additional jobs in the economy. The lower number would apply to the case where all additional logging and sawmilling jobs were filled by local labour and the higher number where both local and migrant labour filled the forestry jobs created.

Under existing world market conditions, it is unlikely that this kind of expansion would be feasible for the companies operating in the area. However, there is a longer run forecast for increased world consumption of forest products, and timber shortages are expected. Even now an upturn in the lumber demand in the U.S. may reduce the threat of countervailing duties against Canadian lumber exports. Under more favourable economic conditions, more intensive use of forests in management units P4 and P5 may become practical. Accessibility remains the major constraint to development, particularly for northern parts of the area.

5.3 Agricultural Potential in the Study Area

Approximately 51 percent or 250,000 acres of the study area is potentially arable. Complete development of the area would provide approximately 500 farms, each with 500 acres of arable land from a total of one, to one and a half sections per unit; or 250 farms, each 1000 acres in size.

Forest management unit P4, in which part of the study area falls, has the largest undeveloped land base classed as 4 or better for agriculture. Unit P4 contains 65 thousand hectares of Class 1 to 3 land and 95 thousand hectares of Class 4 land. There are another 22 thousand hectares of Class 1 to 3 land and 51 thousand hectares of Class 4 land in Management Unit P5.

Most of this land falls within the Green Zone and is currently under the control of the Department of Energy and Natural Resources. Any proposed agricultural development in the area would be subject to the normal planning and approval procedures.

Concerns have been expressed by professionals of both Alberta Agriculture and Energy and Natural Resources regarding the potential effects of land clearing on soil and water conservation, and fish and wildlife habitat. Where farming has been extended to the river breaks in other areas, the results have been slumping, and silting of the water supply. To avoid this, adequate bands of permanent trees must be maintained along the water courses. There is also potential for increased water problems with road construction. Proper planning, with construction in harmony with topography and drainage, should result in improved water relations rather than additional drainage problems.

Conversion of this block of land, currently under a mixture of aspen forest, spruce and muskeg, would not only remove a supply of timber, but would also remove an area of wildlife habitat and would have some negative effects on water shed management.

The loss of timber can be measured in terms of the current harvest and its economic value. Currently, the annual harvest is valued at approximately $750 thousand. Employment generated in the harvest activity is 30 - 35 jobs for 3 - 4 months per year and another 20 - 25 jobs in sawmilling. It can be assumed that the loss of timber quotas would be compensated for by quota in another area and that these jobs would be retained. However, for purposes of the agriculture project, the loss of these jobs would be a cost to the project. Another cost, not easily measured, is the loss of wildlife habitat and loss of a recreational facility.

This study examined the direct costs of establishing farms in the study area: the costs of providing infrastructure (roads and power) and the cost of clearing the land. Road costs were provided by the Department of Transportation and power costs by Alberta Power. Clearing, breaking and cultivation costs were derived from consensus studies of Alberta Agriculture.

With access either from secondary road 686 via Three Creeks, or from Manning via a ferry across the Peace River, the road costs would be $49 million and $50 million respectively. There would be an additional maintenance cost of $180,000 per year where a ferry is included. Construction of a bridge across the Peace would increase the cost by another $17 million. The estimated cost for supplying power to the area is $4 million.

Together, road and power costs would be $53 million or $54 million via Three Creeks or via Manning by ferry. The inclusion of a bridge brings the total cost to $70 million. For the first two alternatives, the per unit cost would be $106 thousand and $108 thousand per farm. Construction of a bridge puts the unit cost at $140 thousand per 500 acre farm.

Land clearing, breaking and tilling costs are estimated at approximately $200 per acre. Costs vary according to the methods used; walking down, piling and disking being slightly less expensive than either cutting, piling and plowing, or walking down, piling and rotovating. The type of cover found in the study area is medium to heavy poplar with some spruce. It is assumed that most of the spruce would be removed before clearing and thus the cutting and piling method would be appropriate. Walking down could also be used in areas of medium to heavy cover where there are little or no trees of less than two inches in diameter. However, in poorly drained areas, as much of the study area is, cutting may be the only method available. The choice of a plow, heavy disc or rototiller, for breaking the land, depends on a number of factors. Unless the land is thoroughly cleared, the plow picks up too many roots, and after plowing, the soil has to be worked down by disking, floating and root raking to prepare a satisfactory seedbed. The plow may also turn the shallow topsoil under, leaving mineral soil at the surface. Even with a disc, the land must be relatively free of roots, large stumps and pieces of wood. Rototilling is ideal for areas under light cover, meadows, and bogs.

An examination of the costs and returns associated with grain and oilseed production in the Peace River Region does not present a very favourable picture. At 1981/82, prices and a crop mix of 25% wheat, 25% canola, and 25% barley and oats, with 25% of the land under clover fallow, the gross returns from a 500 acre farm would be approximately $41,800. Direct cash costs of $21,700 and cash overhead costs of $5,900 produce a return over cash costs of $14,200. With depreciation costs of $10,200, the net return is only $4,000 per annum.

These estimates are based on yields which approximate those of crops grown on soils rated "B" in Peace River, by the Hail and Crop Insurance Corporation. These yields are close to or below the yields used in consensus studies for Peace River. At lower yields which may pertain to lower rated soils (e.g. for soil rated "C"), returns after cash costs are less than $10,000 and for soils rated "D" down to $6,000. These returns do not cover depreciation costs on a 500 acre farm.

Adjusting the crop mix to reflect a lower proportion of wheat, due to the short growing season, reduces the potential returns. This adjustment includes 40 percent of the lower value barley and 20 percent each of wheat and canola. Also, adjusting yields to reflect the ten year average for the Peace River area further reduces returns. The net effect of these adjustments is a fall in returns over cash costs by $2,200 to $12,000 and a fall in net return of $2,500 to $1,500, on a 500 acre farm.

These lower yields are closer to the yields reported by the Hail and Crop Insurance Corporation for crops grown on stubble, while costs used in the estimates are those associated with 20 percent clover fallow. Thus, these latter estimates may be below the potential return.

Assuming that higher proportions of wheat and canola (25 percent each) are possible and that higher average yields are achieved, with a 25 percent clover fallow in the rotation, the original estimates were adjusted to reflect possible changes in costs and prices. For a 10% reduction in costs, there is an increase in returns after cash costs of approximately $2,760 per 500 acre farm. Changes in prices of similar magnitude result in slightly greater effects on returns.

5.4 Project Analysis

Analysis of the proposed agricultural project, using discounting methods produced the following results:

Net Present Value (Million dollars)

	Phasing in of Project					
	3 Years		5 Years		10 Years	
Discount Rate	To Farmers	To Society	To Farmers	To Society	To Farmers	To Society
5%	22,145	-40,565	19,553	-40,974	18,501	-34,850
10%	-7,651	-64,926	-7,078	-60,664	-2,385	-44,841
15%	-20,422	-72,999	-17,637	-65,493	-9,799	-44,475

Benefit-Cost Ratio

	Phasing in of Project					
	3 Years		5 Years		10 Years	
Discount Rate	To Farmers	To Society	To Farmers	To Society	To Farmers	To Society
5%	1.36	0.67	1.34	0.65	1.36	0.67
10%	0.86	0.42	0.86	0.42	0.94	0.46
15%	0.60	0.29	0.61	0.29	0.71	0.35

Internal Rate of Return

To Farmers	8% to 9%
To Society	< 1% to 1%

On the basis of the above results, it would be feasible for farmers to invest in this type of project at discount rates of 8 percent or less. At this rate all capital expenditure on land purchase and development is covered by the net cash flow, resulting from the investment and, accruing over 25 years. From society's point of view the project is only feasible at a discount rate of 1 percent.

It should be noted that all three discounted measures of project worth are "partial" analysis. They are based on the assumption that the project is too small in relation to the whole economy to have a significant impact on the economy in general, or prices in particular.

Secondly, partial analysis evaluates the direct output of the project and the costs of attaining this output. Secondary costs and benefits are not evaluated. Secondary costs include loss of forestry products and employment, wildlife habitat, and soil and water protection. Additional costs relate to the supply of social facilities and services and the expansion of facilities such as grain elevators.

Secondary benefits include those (1) "stemming from" or "induced by" the investment; (2) those due to scale economics; and (3) "dynamic secondary effects" which change the form or productivity of the resources involved. The latter two types are difficult to evaluate and more effort has been put into evaluating the first form, through multiplier analysis.

The most common method of measuring the multiplier effect is through employment generated. Assuming that a total of 900 jobs would be created through the project (1.8 jobs per farm), each for a period of 5 to 6 months per year, the total number of man years of basic employment would be approximately 405 per annum. Using a multiplier of 2.0 there would be 1800 additional non-basic jobs created elsewhere in the economy, equivalent to 810 man-years per annum. The values would be lower if 1000 acre farms were established instead of 500 acre farms.

Other "intangible" benefits would also accrue, these may include better income distribution or a better life for rural people. They do not lend themselves well to evaluation although they are real and reflect true values.

There are a number of cleared and tilled parcels of land for sale and land prices have been dropping. This takes some pressure off the demand for new land, but only where the prospective buyer has access to the capital needed for purchase of an established farm. There still remains a class of prospective buyers only able or willing to approach agriculture through gradual development, with relatively lower initial capital output and phased clearing and tilling.

This study examined the costs associated with farming for grain and oilseed production only. However, there are other more specialized activities such as forage seed production and bee production which exist on a fairly wide-spread scale in the Peace River Region. With a large percentage of Canada's total forage seed produced in Peace River and increasing Eurpoean, American, Japanese, Argentine and Australian markets, forage seed production can be more lucrative than production of grains. A related industry, leaf cutter bees and honey bees which pollinate flowering legumes, can be a major lucrative industry in certain regions, where forage seed production dominates. These two activities definitely contribute towards making farming in the north more viable. Dairy production is also successful, but on a smaller scale, with production geared mainly for the local market. Beef production, while forming an important part of some farming enterprises, is not as successful or attractive as it is in southern Alberta.

5.5 Conclusions

In the final analysis, the decision on whether to convert the study area into agricultural use will hinge partly on the demand for this land for each alternate use, and on socio-economic conditions which affect this demand. More importantly, the success of such a project will be greatly dependent not only on the bio-physical factors which place limits on agricultural productivity and the attractiveness of farming, but on the interaction of these factors with socio-economic factors. These latter factors either increase the limitations caused by bio-physical factors, if they are lacking or unfavorable; or reduce or modify these limitations; if they are favourable and adequate.

Thus, proper access, an adequate supply of power, water, gas, and reasonably easy access to schools, health care and recreational facilities could go a long way to making farming in the study area more attractive and feasible.

Discussions with Agriculture personnel in Peace River and Fairview verify that there is a demand for land in the area. A major part of this demand is by existing established farmers who either want to expand to accommodate sons or sons-in-law in partnership, or to provide a home farm for a son or son-in-law. There is also some demand from outside the area.

Last year, 1023 new farms were developed in the Peace River region and for each parcel disposed of, there were at least two or three bonafide applicants. Most of the expansion is occurring in the Manning and Fort Vermilion areas with minimal clearing of individual quarters in the Peace River area. Currently, land clearing equipment is more readily available for use in agriculture because of the slack in the oil patch; and land clearing and breaking costs are slightly lower than a year ago.

The individual farmer's decision to invest in the project examined will involve a number of value judgements. The calculated net returns on an annual basis as well as on a long term discounted basis are not very attractive. Factors which will influence the individual's decision will include some notion of a time preference for money, the conditions of financing, alternate opportunities for employment and a number of attitudinal factors.

In the final analysis, selection of a project depends on a whole range of considerations which must of necessity rest on subjective judgment. The settlement project analysed in this study does not have a positive net present value to the economy as a whole and has a relatively low value to the farmers. However, the public investment decision must be a political act summing up the best judgment of those responsible, taking into account the public cost and the expected social benefits.

The decision to change the use of the land from one of extensive forestry, wildlife and related uses, to that of intensive agricultural production, can only be partly based on the economic returns of each use, such as gross revenue and employment:

Forestry - 0.8 million dollars/annum
Agriculture - 20.9 million dollars/annum
Forestry - 16 man-years of employment
Agriculture - 405 man-years of employment.

It has to take into account the number of other factors discussed. Specifically, the loss of secondary benefits of forests and the gain of induced benefits from the project, must be evaluated against the large cost of providing the necessary infrastructure and services.

APPENDIX I

MARKET CONDITIONS FOR AGRICULTURE AND FORESTRY

Agricultural Market Conditions

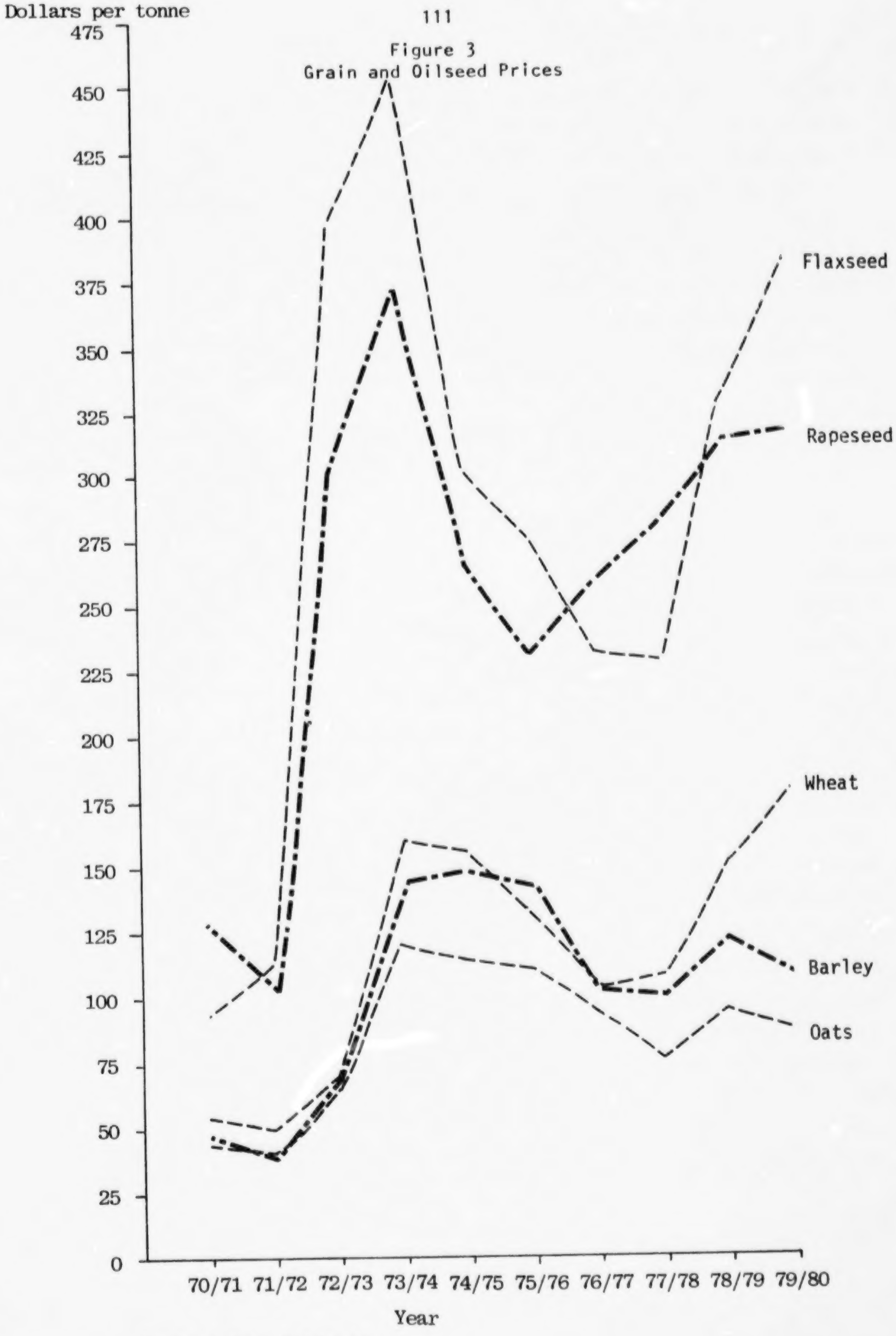
Canada plays a very significant role in world exports of grains and oilseeds, thus any examination of the Canadian market conditions for grains and oilseeds must reflect the happenings on the international market.

The 1970's saw record supply, demand, and marketings of grains and oilseeds. Record demand was brought about by rising population, and by developed and developing nations emphasizing improved diets that contained more wheat and animal protein. Economic development by developing nations lead to greater incomes thus greater demand for improved diets. In many developed countries such as the Soviet Union governments placed food and nutrition on top of the priority list and imported large volumes of feed grains to expand their cattle industry. In the U.S.A., cheap reliable supplies of feed grains gave farmers incentive to produce more animal protein (Brannan, 1980).

In response to this world demand, world production of grain increased by over 30 million tonnes per annum during the 1970's with trade increasing a dramatic 67% from 1970/71 to 1979/80 (Spafford, 1980 and Brannan, 1980). However, even with substantial production increases, consumption has been keeping pace with, and at times going beyond production increases. For example, in 1972 supplies were depleted resulting in a very tight supply-demand situation which sent prices rocketing. The period 1976 to 1978 saw balanced supply and demand with reasonably stable prices (Brannan, 1980). Canadian prices reflected these changes as shown in Figure 3.

Currently long term projections point to a bright future for Canadian grain production and exports. Increased grain utilization is expected, but at a slower rate than in the past. For example, in 1980 -

Figure 3
Grain and Oilseed Prices



Derived from Table 25.

1985 grain demand is expected to increase at a significantly lower annual rate than during the early 1970's. This will be due to an almost static demand for grain in developed countries and a slow down in demand in developing countries - a slow down that will not affect their dependence on major exporting countries such as Canada. In developing nations, production per person has either leveled off or decreased ensuring a continuation of a growing international wheat trade. Demand for feed grain is expected to grow but again at a slower rate than in the past (Brannan, 1980).

The future marketing conditions for oilseeds is harder to determine. The world's per capita consumption of fats and proteins is only a fraction of what it should be, and increased demand is only possible when supply is high and prices are low to moderate - a situation which discourages farmers from producing oilseed crops. Excess supply for oilseeds is not likely except when good weather causes supplies to jump sharply. However, disregarding supply and demand, and prices, increases in the world population in the years to come will definitely have an increasing effect on oilseed demand (Bartholomew, 1980).

As would be expected, wheat prices fluctuate inversely with, but lag behind, changes in volume of exports. While imports dropped from a peak of 13,411 thousand tonnes in 1972/73 to lows of less than 10,000 in 1973/74 to 1975/76, prices rose from $50 to $70 per tonne to $130 to $160 per tonne. Current market conditions (includes 1979 - 1982) for Canadian wheat show a similar trend. Figure 3 indicates that wheat prices rose during the 1979/80 season due to a 20% reduction in global wheat stocks (Spafford, 1980). In 1980/81, cash grain closing prices were 9.9 dollars per tonne higher compared to 1979/80 (Table 25). Significantly lower prices for 1981/82 are in store due to higher world production, smaller increases in world demand, and a rise in world wheat stocks (Fulton 1982). United States wheat stocks have risen in the past year due to the Soviet Union's avoidance of the U.S. market in order to

TABLE 25
GRAIN AND OIL SEED PRICES
1970/71 - 1980/81
Wheat 3 C.W.R.S.

Crop year	Canadian Wheat Board Payments to Producers, Basis in Store Thunder Bay or Vancouver. dollars per tonne	Cash Grain Prices Closing Price[1] dollars per tonne
1970/71	54.34	-
1971/72	49.75	-
1972/73	73.27	-
1973/74	160.68	-
1974/75	156.60	129.34
1975/76	132.79	115.74
1976/77	104.35	85.70
1977/78	107.17	101.10
1978/79	150.11	130.40
1979/80	179.18	159.60
1980/81	-	169.50

[1] Cash grain prices reflect the transactions made on the cash market of the Winnipeg Commodity Exchange basis delivery at terminal position.

TABLE 25 (Cont'd)
GRAIN AND OIL SEED PRICES
1970/71 - 1980/81
Oats 1 C.W.

Crop year	Canadian Wheat Board Payments to Producers, Basis in Store Thunder Bay or Vancouver dollars per tonne	Cash Grain Prices Closing Prices dollars per tonne
1970/71	44.16	45.88
1971/72	43.96	46.20
1972/73	71.39	51.23
1973/74	118.34	130.33
1974/75	114.64	106.67
1975/76	111.27	80.40
1976/77	90.84	65.00
1977/78	77.81	79.50
1978/79	95.56	111.00
1979/80	88.00	136.00
1980/81	-	125.30

TABLE 25 (Cont'd)
GRAIN AND OIL SEED PRICES
1970/71 - 1980/81
Barley 1 C.W. 6 Row

Crop year	Canadian Wheat Board Payments to Producer, Basis In Store Thunder Bay or Vancouver dollars per tonne	Cash Grain Prices Closing Price dollars per tonne
1970/71	47.30	50.06
1971/72	42.71	52.30
1972/73	72.11	118.50
1973/74	143.07	146.98
1974/75	149.91	158.69
1975/76	142.79	137.45
1976/77	103.75	76.90
1977/78	100.90	99.00
1978/79	123.54	152.10
1979/80	110.67	204.70
1980/81	-	170.10

TABLE 25 (Cont'd)
GRAIN AND OIL SEED PRICES
1970/71 - 1980/81

	Flaxseed 1 C.W.	Rapeseed 1 Can.
Crop year	Cash grain prices Closing prices dollars per tonne	Cash grain prices Closing prices dollars per tonne
1970/71	93.50	126.21
1971/72	113.77	104.72
1972/73	391.32	304.68
1973/74	462.69	372.14
1974/75	302.35	267.86
1975/76	276.76	233.36
1976/77	234.70	260.00
1977/78	230.25	282.00
1978/79	327.30	316.40
1979/80	382.40	318.30
1980/81	359.10	334.90

Source: Canadian Grain Industry Statistical Handbook 81. Canada Grains Council: Winnipeg, Manitoba minimize its vulnerability to another grain embargo. Since the United States is very prominent in the world wheat trade, the high level of U.S. wheat stocks is a major factor controlling world grain prices (Financial Post, October 16, 1982). Little improvement for wheat prices in 1982/83 is expected due to an increase in world wheat production and the large carry over in stocks (Fulton, 1982).

Export prospects for Canadian wheat look good - the 1979/1981 period saw an increase in exports (Table 26 and Figure 4) and in May, 1981, the Soviet Union signed a long term agreement promising to buy a minimum of 25 million tons of grain over 5 years. In carrying out part of this deal, in the fall of 1982, the Soviet Union agreed to a record deal of 7.6 million metric tons of grain worth 1.3 - 1.5 million dollars (Globe and Mail, October 14, 1982).

Canada benefited enormously from the Soviet Unions' move away from the U.S. market - in fact, the volume of Canadian exports to the Soviet Union increased more than 40 percent in the first eight months of 1982. Also, due to the improvement in the grain transportation system, overall grain exports have increased in 1982. These increased exports more than offset the lower prices and the value of Canadian grain exports may be well over 7 billion dollars compared to last years' 6.7 billion (Financial Post, October 16, 1982).

The current barley market does not look very good. After record crops in 1976 the international market was glutted. Continued increases in barley acreage in 1977 kept adding to this surplus so by 1978 prices slumped to a new low (Figure 3); and 1978 and 1979 saw barley acreage in Canada sharply cut (Perkins, 1980). In March 1980, Douglas O. Ford, president of the Winnipeg Commodity Exchange discussed the anticipated increased demand for barley in the domestic and export markets for the 1980 crop. Despite a large surplus of U.S. corn, he was optimistic on the prospects of barley in 1980. The same convention, Accent: 1980 Market Prospects for Grains and Oilseeds, brought to light another viewpoint. Perkins, president at Herald Grain Ltd., Winnipeg, felt that overall demand in 1980 had not and would not improve, and in

TABLE 26

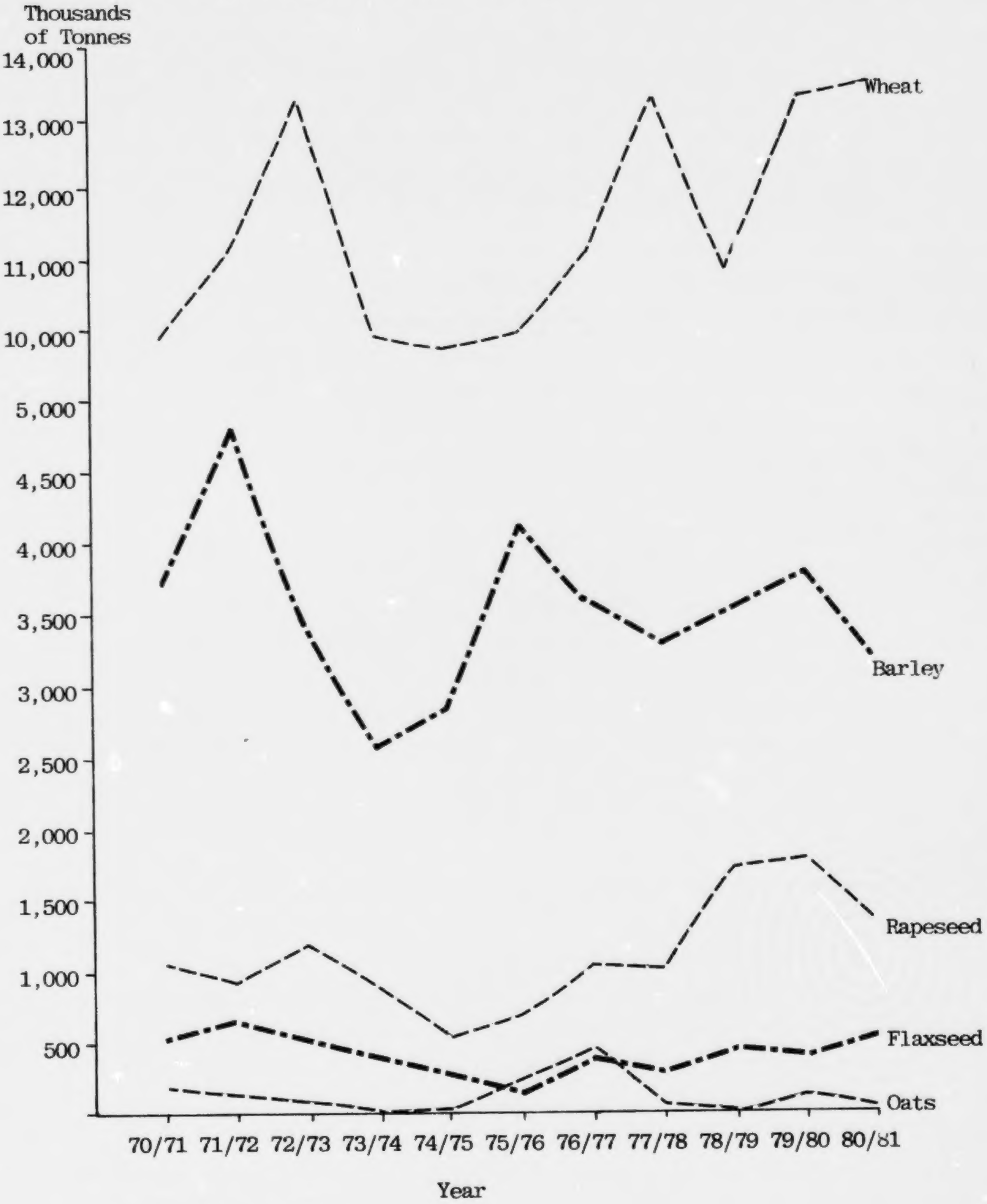
SUMMARY OF BULK EXPORTS OF GRAIN AND OILSEEDS, 1970/71 - 1980/81

Crop year	Thousands of tonnes				
	Wheat	Oats	Barley	Flaxseed	Rapeseed/ Canola
1970/71	9,790	202	3,750	538	1,061
1971/72	11,277	157	4,883	654	966
1972/73	13,411	104	3,415	499	1,226
1973/74	9,628	12	2,583	394	889
1974/75	8,803	21	2,835	267	593
1975/76	9,970	280	4,155	195	683
1976/77	11,013	491	3,609	356	1,018
1977/78	13,271	89	3,349	263	1,013
1978/79	10,949	13	3,554	494	1,720
1979/80	13,264	101	3,831	455	1,743
1980/81	13,492	45	3,236	519	1,372

Source: Canadian Grain Industry Statistical Handbook 81. Canada Grain Council: Winnipeg, Manitoba

Figure 4

Bulk Exports of Grain and Oilseeds



Derived from Table 26.

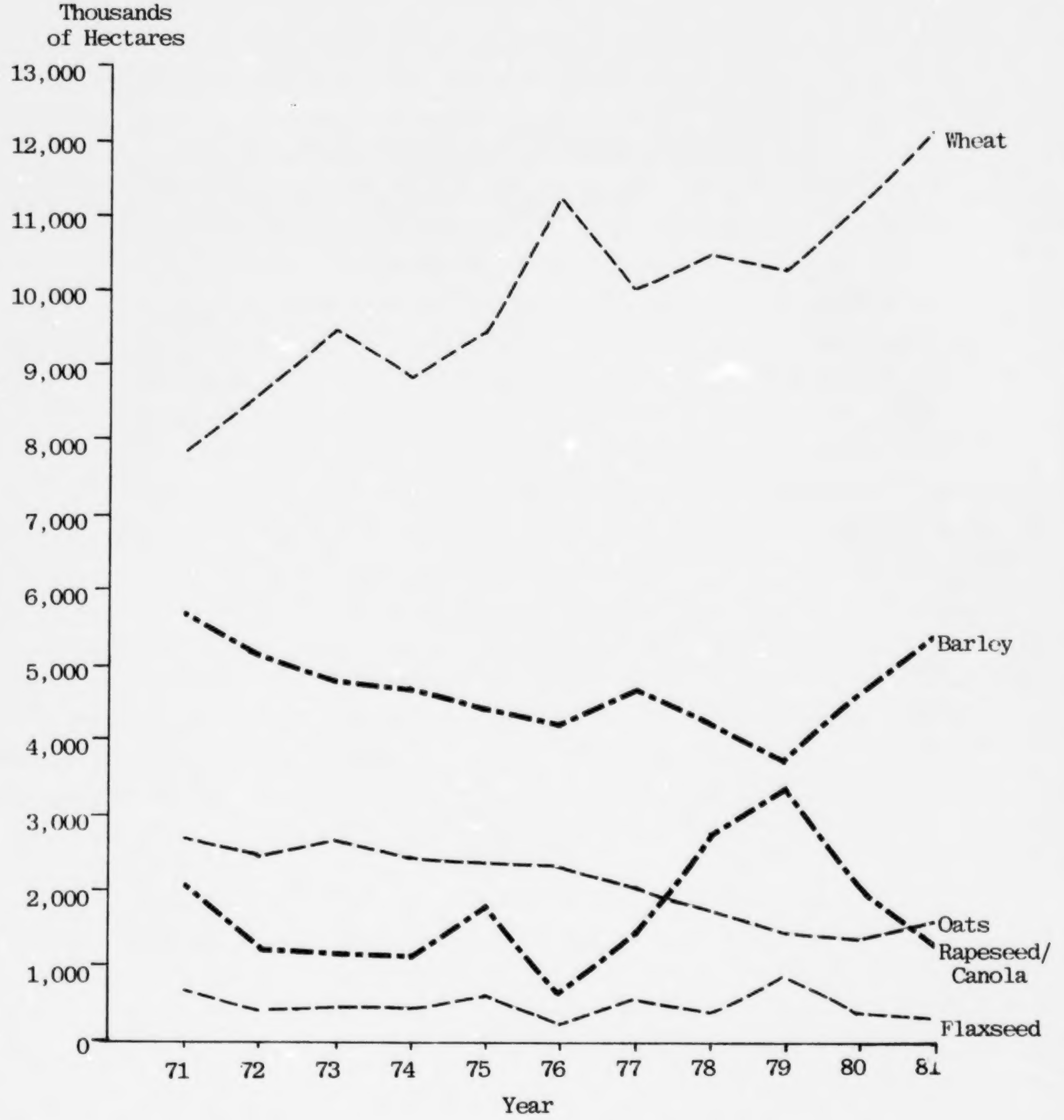
fact had got worse in the eastern feed market. He also felt that the large surplus of U.S. corn on the market would have detrimental effects on the barley market in terms of price and demand. Farmers believed that demand for barley increased in 1980; therefore, they increased their barley acreage in 1980 and 1981 (Figure 5). However, as shown in Table 26, barley prices dropped in 1979/80 and cash grain closing prices for barley dropped 34.6 dollars per tonne from 1979/80 to 1980/81.

Exports increased slightly in 1979/80; however, dropped sharply in 1980/81 (Figure 4). It seems that Perkins' (1980) bleak predictions for the immediate future of barley were correct. In the 1981/82 crop year, world demand for coarse grains was still weak while supplies rose to a record high. As a result, North American prices dropped 15 - 20 percent below the 1980/81 crop year averages, while 1982/83 prices are expected to improve only slightly. The only bright spot in the barley market is that export levels of Canadian barley rose to record levels in 1982 and exports are expected to be high in 1982/83 (Groenewegen, 1982).

Currently oilseeds have also seen a slump on the market. As mentioned previously, an excess supply of oilseeds is not likely unless good weather sharply increases supplies. Unfortunately 1979/80 saw excess world supplies of canola/rapeseed (Bartholomew, 1980), along with lowered demand for both edible oil and meal (Duncker, 1981). As a result Canadian exports of canola dropped in 1979/80 and 1980/81, and acreage has substantially dropped since 1979 (Figures 4 and 5). Prices in 1979/80 rose very slightly - a change from the large price increases that occurred from 1975/76 to 1978/79. However, cash grain closing prices for rapeseed showed an increase of 16.6 dollars per tonne from 1979/80 to 1980/81 (Table 25). Oilseed prices in 1981/82 increased slightly from low levels due to reduced supplies and increased demand and then decreased again due to prospects of increased production for 1982/83. Moderate price increases are expected for 1982/83 due to increased demand. Exports and crushing in 1981/82 of Canadian canola/rapeseed remained low due to a tight supply situation in Canada - a result of reduced acreage. The 1982/83 supply exports and crushing are expected to be reduced - again due to the tight Canadian supply situation (Duncker, 1982).

Figure 5

Area of Principal Crops



Derived from Canadian Grain Industry Statistics Handbook 81
Canada Grain Council

Forestry Market Conditions

World consumption trends for forest products were projected to be uniformly buoyant in the 1980's (Reed, 1979). Consumption of paper and paperboard grew by more than 5% annually during 1948 - 49 to 1973 - 74. The F.A.O. Secretariat projected growth to be 4.3% during the decades of the 1980's and 1990's and the Stanford Research Institute projected a 3.5% growth rate. A 3.5 percentage point increase would require an increase in the world capacity to produce pulp and paper by about 75 million additional tons during the 1980's alone. Reed (1979) states that it would be very difficult for the world to achieve these growth rates and that extraordinary opportunities for increasing Canadian production, employment and export earnings exist.

Lower yet, significant increases of 1 - 2% in lumber and wood-based panel consumption are also projected. Softwood lumber consumption is expected to grow by 70 million m^3 annually by the year 2000; nearly double Canada's present output of sawn softwood. Over the same period hardwood lumber growth is projected to increase by over 40 million m^3.

Combining Statistics Canada selling price indices for the wood industries (1971 = 100) and an indicator showing average yearly prices (net f.o.b. mill) a trend in lumber prices can be traced from 1956 to 1982 inclusive. The price index remained stable at approximately 70 with little fluctuation from 1956 to 1963. The period 1963 to 1967 saw a gradual increase in the price index from 72.9 to 82.9.

During 1968 to 1982 there were drastic price fluctuations, as reflected similarly by both the price indices and the average yearly values of the indicator. The prices of the indicator show a slight decrease from 95 dollars per thousand board feet (t.b.f.) in 1968 to 92 dollars per t.b.f. in 1969. Prices then dropped a substantial 19 dollars per t.b.f. from 1969 to 1970.

After this drop, prices rose sharply from 73 dollars per t.b.f. in 1970 to 151 dollars per t.b.f. in 1973, only to drop to 120 dollars per t.b.f. in 1974. 1975 saw a slight decrease in prices from 1974; however, by 1976 prices had risen again to 1973 levels. Prices continued to rise sharply peaking in 1979 at 225 dollars per t.b.f. 1980 saw a substantial drop to 168 dollars per t.b.f. and prices continued to decline in 1981 and again in 1982 to a low price of 137 dollars per t.b.f.

These price changes are presented in Table 27 and shown graphically in Figure 6. Based on previous forecasts of growth in demand for forest products, together with a lag in the supply growth, it is expected that within the next two decades there will be another upturn in prices.

The Canadian economy and particularly the forestry industry are greatly dependent on trade and foreign investment for growth. The forest sector exists on the basis of an export market, exporting 90% of newsprint shipments, 70% of lumber and 60% of chemical pulp. Almost 30% of manufactured forest products which enter world trade originate in Canada and Canada is by far the largest single supplier (Reed, 1979). The Prairie provinces together contribute 3 percent of the forest products exports (Reed, 1973); not a very significant proportion. However, Alberta forests are one of the last areas with potential for increased production. There is no doubt that the opportunity for growth in production and shipments of forest products exists. What is inadequate is the level of investment in the industry to boost supply to meet this growing demand.

TABLE 27

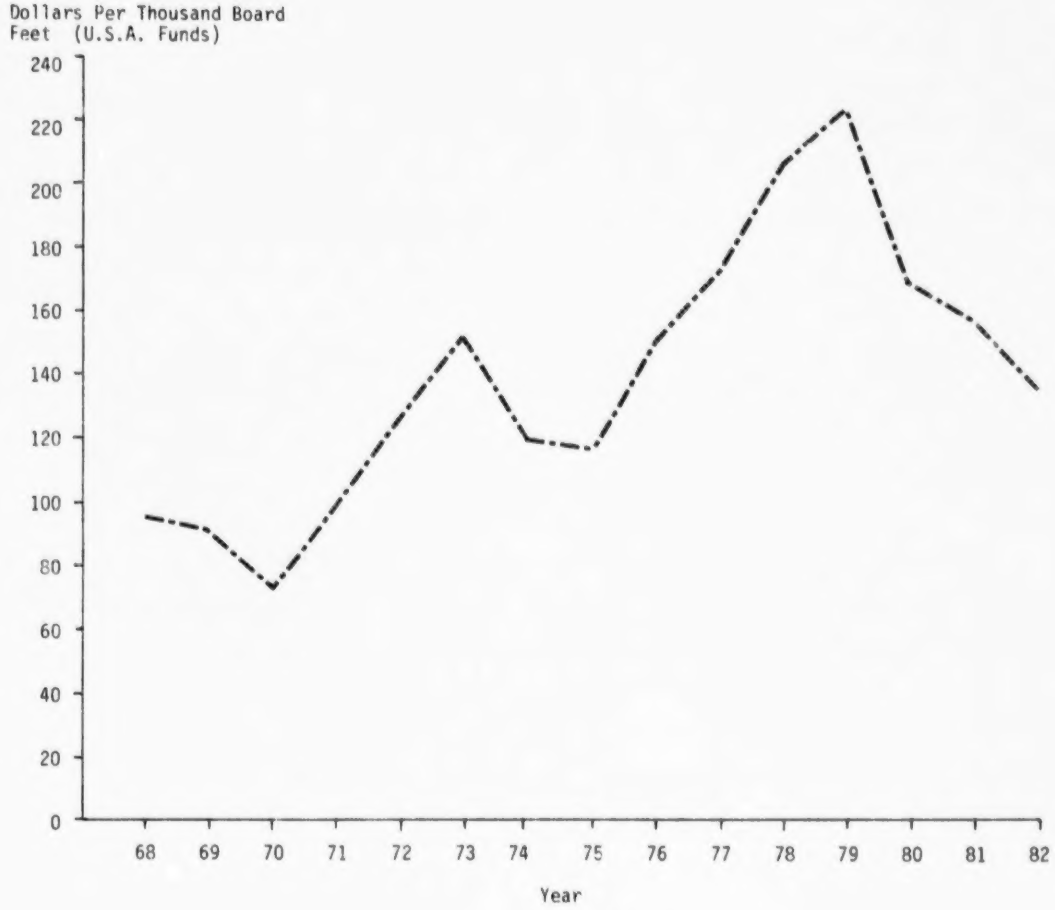
SUMMARY OF LUMBER PRICES [1/]
YEARLY AVERAGES
1968-1982

Year	Dollars Per Thousand Board Feet (U.S.A. Funds)
1968	95.00
1969	92.33
1970	73.33
1971	99.17
1972	126.33
1973	151.92
1974	120.17
1975	117.42
1976	151.17
1977	172.92
1978	209.25
1979	225.00
1980	168.42
1981	156.08
1982	137.82

1/ Prices Net f.o.b. mill. Indicator - Spruce, Pine, Fir, Western, Kilm Dried 2x4, Standard Btr. Random 8/20.

Source - Yearbooks. Random Lengths Publications Inc.
P.O. Box 867, Eugene, Oregon 97440.

Figure 6
Lumber Prices



Derived from Table 27

According to Reed (1979), the all-Canadian timber totals give the mistaken impression that the forest industry still has a comfortable reserve to draw on. Provincial totals show over commitments in the Maritimes and raises doubts about expansion potential in other provinces. Approximately half of the timber reserves are economically inaccessible and the accessible half is relatively less attractive than what is currently being harvested. In the publication Canada's Forest Inventory - 1976, Bowen (1978) estimates that 32% of Canada's production (vs. reserved) forest is unproductive and 19% of the productive forest land is inaccessible. This indicates that only 55% of the production forest is productive and accessible. Reed (1979) estimates that 17% of the annual allowable cut is inaccessible.

One major problem to obtaining accurate estimates is that inventory data are at least 20 years or more old in some places. Moreover there is no continuous forest inventory and data cannot be readily updated to reflect losses.

A significant increase in the supply of timber could prevent price increases but only modest increases in available wood on the world market are projected, even by optimists (Dutrow, 1979). Historical evidence and a number of estimated projections indicate that land devoted to commercial production of wood fibre has declined and will continue to do so. Dutrow expressed the opinion that the trend of rising relative prices for wood and wood products would likely extend indefinitely into the future.

Currently, markets are slumping. The Financial Post (October 16, 1982) reported that operating rates across Canada for the first seven months of 1982 were 81% for wood pulp and chemical grades of paper (vs 89% for 1981), 86% for newsprint (vs 95%) and 76% for paperboard (vs 93%). Mill inventories have also increased drastically indicating operating rates are too high. In mid-1982 the New Brunswick industry was operating at 80% of its previous year's level. British Columbia producers are operating at 70% to 80% capacity because of plunging markets in North America and Northern Europe. Curtailments and layoffs in the pulp and paper industry are likely to continue and lumber prices are down drastically (Financial Post, October 9, 1982).

However, it is expected that this situation is not long term but reflects the general world recession, and markets and employment will be restored in the near future. As with other industries, recovery has been variously predicted for mid 1983 to 1984.

Because of the relatively weak Canadian dollar and the fact that a large proportion of sales are in the U.S. and in U.S. dollars, companies have been able to survive. The devalued Swedish krona is expected to put more price pressure on B.C. pulp producers since Sweden is one of Canada's main competitors for the big European markets (Globe and Mail, October 12, 1982). Another threat to Canadian producers is the developing protectionist trend, particularly in the U.S. Canadian lumber is among the current targets of U.S. protectionist forces. A score of U.S. "reciprocity" bills, which deny any nation access to the U.S. market for specific goods and services not granted identical access in the exporter's market, threaten additional havoc for Canada and the international trading system generally (Financial Post, October 16, 1982). At November's (1982) meeting of the General Agreement of Tariffs and Trade (G.A.T.T.) in Geneva, trade ministers had the opportunity to attempt to slow the tide of protectionism.

Meanwhile, the U.S. International Trade Commission (ITC) hearing into the claims of U.S. lumber producers, of injury from soft wood imports from Canada, resulted in the decision that the U.S. Commerce Department should review the sale of Canadian building products. This review is to determine whether the injury is caused by government subsidies to Canadian manufacturers of building products. If it were to find that there are subsidies, the U.S. government could then slap a countervailing duty on Canadian products to artificially raise their price (Globe and Mail, November 19, 1982).

Returning to the longer term prospects it is perhaps most important to examine Canada's future production and exports in light of the U.S. industry and demand. Adams and Haynes (1980) presented a spatial model of North American softwood lumber plywood and stumpage markets designed to provide long-range projections of price, consumption, and production trends. Their results indicate that rates of forest product and stumpage price growth will be higher than long-term historical rates between 1980 and 1990 but at or below historical rates between 1990 and 2030. Canadian exports of lumber to the United States are projected to expand during the next two decades and contract after 2000.

The model, the Timber Assessment Market Model (T.A.M.M.) is a combination of market forms and is partitioned into two major sections, "final products" (lumber, plywood, pulp, etc.) and "stumpage". Nine geographic stumpage and final product regions are recognized and six final product demand regions. T.A.M.M. is an annual model; equilibrium solutions are found in each year by first reducing the lumber and plywood supply relations to functional forms involving only product market prices and quantities and predetermined variables from the stumpage sector.

To balance demands with available supplies of timber, especially softwood sawtimber, substantial increases in prices of timber products relative to the general price level would be necessary. Adams and Haynes (1980) project that Canada will play a pivotal role in determining future price and consumption levels of lumber in U.S. markets. The model suggests that rapid growth will continue through 1990 as U.S. demand expands. Afterwards, growth in Canadian exports to the U.S. slows and the share of U.S. consumption declines after the year 2000 as Canadian production costs rise to slightly above the levels experienced in northwest U.S.A.

To achieve the projected lumber production growth by 1990 of nearly 34% above 1973 levels, would entail the use of species and log grades not currently merchantable and harvesting operations in stands with substantially less favorable conditions than present operations.

Up to the year 2000 Canadian costs are projected to remain below most U.S. regions and only slightly above ($2 to $3 per thousand board feet) the Pacific northwest - eastside (P.N.W.E.) and the Pacific southwest (P.S.W.). However, by 2030 Canadian costs surpass those of all U.S. regions except south central (S.C.) and southeast (S.E.).

Similarly, Canadian prices which in 1974 were substantially below the 1976 U.S. prices, are expected to rise to levels closer to most U.S. prices by the year 2000 and to be slightly above most regions by 2030. Prices in S.C. and S.E. regions remain above Canadian prices.

Modifications to T.A.M.M. were used to determine the impact of changes in management and trade policies in the U.S. The effects of intensified private management would be gradual but by 2030 domestic lumber production could replace imports from Canada. A ban on U.S. log exports would produce an increase in export of Canadian (and U.S.) lumber to offshore markets and a reduction of Canadian shipments to the U.S. The impact of a 15 percent ad valorem duty on Canadian softwood timber imports would be an increase in U.S. lumber output (by 12%) and softwood prices (by 9%), a drop in Canadian imports of 41% and a 5% decline in U.S. consumption by the year 2000.

If the planned reduction in rotation lengths used in British Columbia from 120 years to roughly 90 years is not undertaken, production costs would increase due to the extension of harvesting into higher cost area. Projected increases of $6/m.b.f. in 2010, $11/m.b.f. in 2020 and $17/m.b.f. in 2030 would result in a 14% decline in Canadian lumber production by 2030 and a 31% decline in Canadian exports to the U.S. Deviations from the U.S. Forest Service harvest flow policy were also simulated. Regional changes have significant impact regionally. Where national change is made and harvests are at current (1978 - 79) rather than potential levels on National Forests, then market responses suggest increases in cuts on private lands and softwood lumber imports from Canada. Even here regional changes are more dramatic.

While current market conditions upset the projections of the model, the possible impact of changes in assumptions is worthy of consideration. Firstly, Canadian exports of lumber to the U.S. are expected to drop after the year 2000 in response to predicted U.S. - Canadian cost differences. Unexpected cost or price increases, such as those due to using higher cost timber in B.C. or a 15% U.S. tariff would result in a further 31% decline and 41% decline in Canadian exports to the U.S. respectively.

With current demand for lumber in a slump, the impact of a tariff or other protectionist action on the part of the U.S. would probably have a more immediate effect on Canadian imports than suggested in the model. U.S. lumber output increase would not depend only on increased timber production, but simply on a return to potential production and possibly use of inventories.

APPENDIX II

AGRICULTURE ON MARGINAL LANDS AND GREY WOODED SOILS

Concept of Marginal Agricultural Land

Research in the area of marginal agricultural lands was reviewed by Beattie et al. (1981) for the Lands Directorate, Environment Canada. Various definitions of marginal lands and different approaches to the study of the subject were presented. Specific examples of marginal agriculture in Canada were discussed and characteristics of marginal agriculture outlined. The following section presents some of these views and attempts to put the study area into this context.

The term marginal, when applied to agricultural land, usually implies some physical limitation or limitations which make farming difficult. Generally some geographic boundary, climatic zone or soil capability boundary is associated with an area of marginal agricultural land. However, these boundaries apply to bio-physical conditions which may be modified by technology or economic conditions and therefore are not necessarily permanent or long term boundaries. A more workable definition of marginal land is one which also takes into account socio-economic conditions and future expected changes in these conditions, and describes marginality in terms of some economic disadvantage.

In Canada, physically marginal lands have been defined specifically as lands of CLI (Canada Land Inventory) Class 6 soils which are only capable of producing perennial forage crops and rough grazing. These lands make up approximately 1½% to 2% of Canada's land area. However, Classes 4 and 5 can also be marginal for field crops if certain adverse physical and socio-economic conditions reduce the capability of land in a locality. Thus, one area of Class 4 soil in one part of Alberta may be more marginal than another area of Class 4 soil in another part of Alberta because of climatic differences, or less marginal than a third area of Class 4 soil because of better access. Whatever the physical characteristics causing relative marginality between areas, it is the economic outcome of these factors which determines whether farming will be viable in one area and not the other area. Francis (1970) describes economically marginal conditions for agriculture as related to factors of location, profit and capitalization. Thus, both spatial remoteness and economic isolation together contribute toward marginality. Economic marginality also refers to farm operations at or near subsistence where levels of return on investment are low and/or where capital deficiencies exist.

Another aspect of marginality is the concept of social marginality. Here deficiencies in social services and amenities and social characteristics of the farming population contribute to the disadvantage of agricultural regions. Factors which relate to this concept are facilities such as education, medical or transport services and characteristics such as aging population, low educational level, lack of farm managerial skills and lack of mobility.

Physical marginality can also be defined in terms of a geographic location. This approach identifies a physical limit or frontier such as a "northern" limit, a clay belt or an agro-climatic zone. Frontier agriculture is associated with such boundaries, and frontier settlement is the subject of several studies. Most of these studies have been descriptive, directed at marginality in physical terms and largely land use oriented. More recently socio-economic analysis has gained the interest of researchers. Studies have focused on the depopulation of small farms and other quantitative analyses on such topics as the income of marginal farms and off-farm work. Another area of interest in marginal lands is derived in part from the loss of better agricultural land to urban uses and in part from the concern for the hungry and a fear of a world food crises.

Among the discussions on physical marginality, Troughton (1977) applies the term marginal to a zone of rural settlement lying between 45 and 55 degrees north latitude in the area called "broken ecumene". This zone includes areas peripherial to core areas of settlement in the west, and some settled areas in eastern Canada. Proudfoot (1974) also describes a northern limit to cultivation. Agro-climate limits have also been defined by Chapman and Brown (1966), Laut (1973c) and Williams (1974).

These discussions all base the limit or frontier for agriculture and therefore the area of marginality on bio-physical characteristics. Up to the mid-1960's, economic and social marginality had been neglected; there was a lack of data and statistics for rural areas. By mid-1965, socio-economic analysis was gaining significance. Szabo (1965) published one of the first statistical analyses of socio-economic variables related to small-scale marginal farms. As agricultural statistical data became more detailed, quantitative analysis was facilitated. More recent studies on "Off Farm Work by Farmers" (Bollman, 1979) and "Canada's Farm Population: Analysis of Income and Related Characteristics" (Shaw, 1979) are based on 1971 Census data.

In 1970, Ironside called for statistical and analytical research into the impact of distance, scale, and location on rural poverty in physically and economically marginal areas. He suggested that other basic statistics be gathered for areas smaller than the census division, so that rural planning needs could be met, and decisions concerning public investment in marginal areas soundly based.

In examining agricultural frontiers, it is found that they seldom coincide directly with actual physical limits to cultivability, but that marginal agriculture represents the interaction between physical and socio-economic factors. It is apparent that the combination of factors of production - land, labour, capital, and management is less than optimal in marginal areas. This, when combined with adverse climatic conditions, puts marginal regions at a severe disadvantage, heightens the socio-economic disparities between the agriculture core and the margin, and increases the pressure for the abandonment of marginal agricultural lands.

The Peace River District of Alberta and British Columbia is an area of grassland soil outside the main Prairie region. In this region, the limits of agricultural production have been extended or advanced, as opposed to the more general trend of retreat in other areas such as the Clay Belt region of western Quebec and northern Ontario.

The warm summer temperatures, the result of: continentiality permitting intensive summer heat; mountain barriers cutting off cool air masses; long summer days, a consequence of latitude; and the "refrigerating" effects of Hudson Bay which prevent an easterly extension of similar warm temperature, are more important to agriculture than the soil types. Early maturation is given a premium for crops such as wheat, barley and oats, because of the short frost-free period and growing season. Long winters and very low temperatures, snow cover and occasional blizzards, are not conducive to mixed farming operations nor range management. Thus, the accent is on cereal crops, with part-time farming and "absentee" farming being quite common. Variation in soil fertility also presents a problem. Generally soil building practices are required and in some localities liming is necessary.

Diversification of practices, and intensification of mixed production on the more suitable lands, appear to be important factors in the future success of agriculture in these northern environments. Also, off-farm work is usually essential because agriculture cannot sustain the northern economies on its own (Lamont and Proudfoot, 1974).

These conclusions have again been substantiated by a study of eight farms in the Peace River region, (Resource Economics Branch, 1982). Some of the findings of that study are: the highly seasonal demand for farm labour due to the short growing season for grain crops; the resulting limits on the acreage an individual can manage and thus on farm income; the need for additional sources of income for both farm investment and family support, and to provide year round employment.

Other findings which are of relevance to the concept of marginality are: the concentration of farm machinery work in a short period, together with grain specialization, making custom work non-feasible and producing high capitalization needs on individual farms; and the concentration of service, repair, and marketing facilities in the area of grain farming and the lack of such facilities for other types of farming, making diversification difficult. Finally, due to the low density of population, community facilities are few and far apart, or lacking. Travelling time to schools, health care, and recreational facilities are long. Mail delivery is limited, and in many instances, connection to the natural gas pipeline and water distribution systems is not possible.

In general, most farmers consider that the community in the Peace River area is too small to justify facilities which approximate those of modern society. Growth of other sectors, such as the oil industry and commodity processing, would create more employment and income and produce a demand for community facilities.

Agriculture on Grey Wooded Soils

With 80 percent of Alberta's potentially arable land located on Luvisolic or Grey Wooded soils, these soils will play a major agricultural role in the future (Alberta Agriculture). There are many problems in farming Grey Wooded soils; however, with recommended management practices that improve the soil, combined with the fact that a large portion of Grey Wooded soil areas receive more reliable moisture than most open prairie areas, crop yields can be equal to or better than yields from black soils (Bentley et al. 1971).

The location, formation and profile of Grey Wooded soils was discussed in Chapter 2 "Physical Description of the Study Area". From this discussion, it is clear that farming these soils presents the farmer with many problems. Since the majority of the Grey Wooded soils are in northern Alberta with shorter frost-free days, poor grades of grain and seeds, and reduced yields can occur due to early frosts. Local variations in frost-free days results in small areas receiving more frost damage than usual. Similarly, local variations in the amount or time of growing season precipitation can severely restrict crop growth in some areas (Bentley et al. 1971).

A good soil such as the organic rich black soils developed on the grasslands exhibit desirable physical and chemical properties. Soil with desirable physical properties is said to have good tilth - that is roots and water penetrate easily, many good sized pores exist to hold both water and air, the surface does not cake or bake, the structure is granular, tilling is easily done, a good seedbed is produced, and resists erosion. Soil with desirable chemical properties contain the essential plant materials (i.e. nitrogen, phosphorus, potassium, sulfur to name a few) in a form available to plants. Alkali and acidic soils are two chemical conditions harmful to plants (Bentley et al. 1971).

The plow or cultivated layer of Grey Wooded soils, low in organic matter and clay, has poor tilth. As a result, when dry it crushes to an ash-like or flour-like powder; when wet it flows together and bakes hard on drying. In fact, hard rains just after seeding may puddle the surface and severe crusting occurs when dry. Reseeding may be necessary due to small seeded crops being unable to push up through the crust. Also penetration of rain water later in the season is restricted resulting in runoff and erosion; pore spaces may become extremely plugged reducing aeration of roots. The subsoil layer dries into hard lumps that may inhibit root penetration, thereby reducing the depth from which crops obtain nutrients and moisture (Bentley et at. 1971).

Grey Wooded soils are also lacking in desirable chemical properties. Bentley et al.(1971) and Robertson (1979) cite nitrogen, sulfur, phosphorus, potassium, manganese and boron as limiting materials in the soil. The results are not only lower yields but lower nutritive value of the crops grown. For example, the protein content of wheat grown on Grey Wooded soils is considerably lower than wheat grown on prairie soils (Bentley et al. 1971). Soil acidity can also be a problem. A soil pH between 6 and 8 is ideal for optimum growth of most crops. Below 6, growth of crops sensitive to soil acidity will be reduced; below 5, growth of many crops is seriously affected (Bentley et al. 1971).

Other problems common to Grey Wooded soil areas are drainage and water related. Occasionally, the subsoil horizon accumulates excessive clay not allowing water to seep through it. Heavy rains or spring thaw result in saturated surface layers. As a result, water and air content of the soil is reduced, soil remains cold, crusting occurs when the soil dries and field operations are delayed. Another drainage problem is associated with low lying areas which hold water or flood (Bentley et al. 1971).

To overcome the problems described and successfully farm Grey Wooded soils, proper clearing and breaking techniques are needed followed by appropriate intensive management practices.

Clearing and Breaking

The methods of clearing and breaking along with the cost vary, depending on the density and height of the tree cover and the nature of the soil. Tree cover is broken down into four types as listed in Table 28 (Friesen et al. 1965).

TABLE 28

CLASSIFICATION FOR LAND CLEARING PURPOSES, BY TYPES OF TREE COVER

Cover Type		Trees Per Acre	Ave. Diameter at 4 ft.
1	Light	250 - 1,000	up to 2"
2	Medium	1,000 - 3,000	4 - 6"
3	Heavy	750 - 2,000	4 - 8"
4	Heavy	500 - 1,500	6 - 14"

SOURCE: Bentley, C.F., Peters, T.W., Hennig, A.M.F, and Walker, D.R., 1971; Grey Wooded Soils and their Management. Bull B-71-1 University of Alberta, Canada, Dept. Agriculture.

Common methods of clearing include cut and pile, walkdown and pile, ball and chain, roller-cutter and rotary or gyro mowing. Cutting and piling require two separate operations - cutting trees close to the ground via a V-shaped cutting blade mounted on a caterpillar, and piling in windrows 200 feet apart using a specially designed piling blade. This method is recommended for cover types 2 and 3 and is ideal for gently rolling hills where light growths of poplar and willow are the dominant species. Trees over 8 inches in diameter should not be cut because large stumps make breaking difficult. Cutting is usually done in the late fall or early winter when the ground is frozen and there is little snow. In poorly drained areas where frost is thick, this is often the only method available to farmers (British Columbia Department of Agriculture, 1973). In the walkdown and pile method, cover types 2 and 3 are easily cleared with a raised, angled blade of a bulldozer (Friesen et al. 1965). Trees less than 2 inches in diameter will spring back after being walked over (British Columbia Department of Agriculture 1973). An advantage to this method is that after bulldozing and piling, most roots are removed thus breaking is easier and little or no root raking is necessary. The best time to bulldoze is in the fall or early spring; this method will not work when the ground is frozen due to the trees breaking off rather than uprooting (Friesen et al 1965, British Columbia Department of Agriculture, 1973).

The cheapest way of clearing large tracts of land (300 acres or more) of cover types 2, 3 and 4 is the ball and chain method. It works well, in both summer (maximum root removal) and winter, cutting swaths 40 - 70 feet wide. The V-shape of the ball and chain tends to pile the trees, especially in the winter. However, more piling is needed before breaking occurs. It has the disadvantage of removing smaller pockets of heavy cover which should be left as windbreaks but has a significant advantage over dozers and cutters on stony soils. The roller-cutter method of clearing, cuts poplars and willows up to 4 inches in diameter at the base. Winter cutting leaves roots intact; however, summer cutting is not recommended as it cuts poorly on soft ground. The rotary of gyro motor can only be used in cover type 1; therefore, they are used more often to cut regrowth of young poplars after a fire, or when breaking has been delayed for 2 or 4 years after clearing and piling (Friesen et al. 1965).

After clearing is complete, a farmer has a choice of either using a moldboard plow, heavy disk, or rototiller to break the land. The moldboard plow is being replaced by the disk for a number of reasons: the plow is slow and costly, unless the land is thoroughly cleared the plow picks up too many roots, and after plowing the soil has to be worked down by disking, floating and root raking to prepare a satisfactory seedbed (Friesen et al. 1965). Friesen et al. (1965) contend that on Grey Wooded soils, the plow turns the organic matter under leaving the mineral soil at the surface to puddle or bake. However, Bentley et al. (1971) state that the moldboard plow works well on all types of soil including Grey Wooded soils as long as breaking is done in June and plowing is no deeper than 4 to 6 inches. Heavy serrated disks are now extensively used due to low costs. Friesen et al. (1965) state that disks can be used after clearing with a bulldozer, V-shaped cutter, ball and chain, or rotary mower. British Columbia Department of Agriculture (1973) contends that the disk will not cut through large amounts of wood 2 - 3 inches in diameter that are lying on the surface. Therefore, land must be relatively free of roots, large stumps and pieces of wood in order for the disk to work well. Advantages of disking over plowing are that disking mixes the topsoil thoroughly into the subsoil making a good seedbed, it also leaves the land in a smoother condition for easy operation of machinery (British Columbia Department of Agriculture 1973).

A heavy rototiller is excellent for breaking and preparing seedbeds in one operation as long as all tree stumps and large roots are removed. This is ideal for areas formerly under light tree cover, meadows, and bogs (Friesen et al. 1965). Friesen et al. (1965) state that rototilling has the advantage of mixing the surface soil with leaf mold and surface organic matter rather than turning it under as with the moldboard plow. On the other hand, British Columbia Department of Agriculture (1973) contends that the rototiller has a mulching effect which tends to destroy the structure of clay soils. Heavy rains followed by drying will cause crusting of this soil.

An important consideration when choosing a clearing and breaking method is costs. Variations of 10% to 20% in costs exist between different methods. No matter what breaking technique is used, tests done in the Peace River area showed that early to mid-season breaking is best, with June being the ideal time because of reduced brush competition. Results showed that yields of wheat for three years after breaking were consistently higher on June breaking than on September breaking (Boyd, 1977).

A considerable amount of breaking and subsequent working of the land is required to achieve a satisfactory seedbed for rotational crops. An example of bringing land into production for rotational crops in the High Prairie area follows. The clearing and breaking is done over a period of two years with seeding of the first crop taking place the following year.

Land Breaking using Moldboard Plow

Year 1 - Brushing and Piling
- Plowing (80%)

Year 2 - Repiling
- Plowing (20%)
- Disking 2x
- Raking (Drum Rate) 1x
- Raking (Wheel Rate) 2x
- Disking 2x

Adapted From: Visser, Peter (1980). A cost study of bringing Virgin land into production in the High Prairie Area. Alberta Agriculture, Economic Services Division, Production Economic Branch.

The extent of breaking and working the land to achieve a satisfactory seedbed for pastures is still debated among authors. Friesen et al. (1965) contend that grasses and grass-legume mixtures seeded for pasture were readily established in shallowly disked and very rough seedbeds. Boyd (1977) cites an example that demonstrated forages could be established using a disk and grain drill on newly cleared land. However, minimal breaking results in rapid and dense woody regrowth that is costly to remove via herbicides, burning and rotary mower (Freisen et al. 1965). In comparison, Mitchell and Allerdings (1977) contend that the preparation of a proper seedbed is one of the most important factors in the achievement of a good pasture stand. All competing species must be eliminated. A study done by Pringle et al. (1973) in the Peace River area looked at the various methods and extent of breaking in relation to woody regrowth. They found that the degree of cultivation has a definite effect on forage establishment, that is, highly developed seedbeds produced excellent stands of grass and legumes. They concluded that pastures on Grey Wooded soils of the Peace River area would have to be created gradually by the use of annual grain cropping for 1 - 2 years to ensure adequate brush removal. This could be done along with an adequate herbicide program prior to establishing a permanent pasture. Thus, Pringle et al.(1973) are of the opinion that production of large scale pastures using rough or once-over methods would not be successful.

Once land is ready for seeding, intensive management practices are needed. The degree of management varies depending on production of rotational crops vs. pasture.

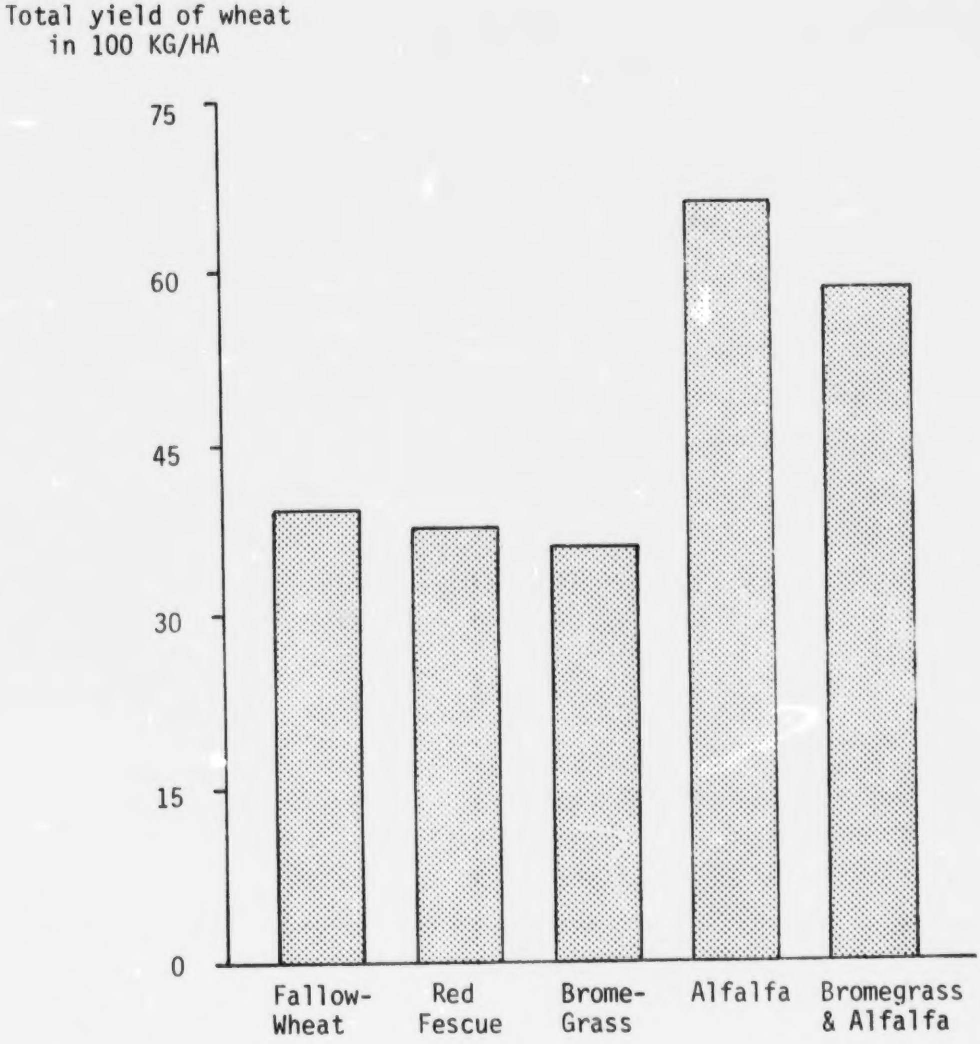
Management Practices - Rotational Crops

Years of research and farming on Grey Wooded soils have resulted in the development of management practices that improve the physical properties of the soil and improve yields.

On Grey Wooded soils, a suitable crop rotation in most cases consists of 2 - 3 years of a legume-forage crop mix followed by 2 - 3 years of cereal or oilseed crops. A fallow-grain rotation is not recommended (Bentley et al. 1971). In a study done by Hoyt and Henning (1971) on Grey Wooded soils, forage-wheat rotations (using different forages) were compared to fallow-wheat rotations. (Results are given in Figure 7). The four wheat crops yielded 93% more when they succeeded alfalfa than when they succeeded grasses (Red Fescue and Brome-grass). Yields of the first, second, fourth and fifth wheat crops succeeding alfalfa were greater than those succeeding fallow by 71, 82, 75 and 68 percent respectively. The researchers found that the effects of the alfalfa on wheat yields were largely the result of nitrogen fixation by Rhizobium bacteria. The release of available nitrogen was much greater after alfalfa or brome-grass plus alfalfa than after any other forage crop. However, by the fifth crop of wheat, the nitrogen difference among the five plots was very little; therefore, the researchers suggested another possible benefit of alfalfa might be the increased

Figure 7

TOTAL YIELDS PRODUCED BY FOUR WHEAT CROPS GROWN SUCCESSIVELY AFTER A FALLOW - WHEAT ROTATION OR SEVERAL FORAGE SWARDS. THE FIRST, SECOND, FOURTH AND FIFTH WHEAT CROPS CONSTITUTE THE TOTAL YIELDS WITH ONLY THE FIFTH CROP RECEIVING FERTILIZER.



Source - Hoyt, P.B., and Hennig, A.M.F. (1971) Effect of alfalfa and grasses on yield of subsequent wheat crops and some chemical properties of a grey wooded soil. Canadian Journal of Soil Science 51:177-183, June, 1971.

permeability of the subsoil by its strong taproot. Results also showed that the age of the forage, 2 - 6 years, did not affect subsequent wheat yields. Bentley et al. (1971) cited results from similar studies that agreed with Hoyts and Henning's results. Robertson (1979) stated that a 5 year rotation of forages and grains leads to a significant improvement of soil tilth when compared to a fallow-grain rotation. The above studies dealt with alfalfa; however, one study cited by Bentley et al. (1971) shows that legumes, red clover and alsike were similar to alfalfa when comparing succeeding grain yields. In summary, Bentley et al. (1971) suggest every effort should be made to include a biennial or perennial legume crop, grown alone or in a mixture with grass, in rotation. The legume can be grown for forage or seed or used as a green manure. Recommended forage mixtures for Grey Wooded soils are given in Table 29.

Mitchell and Allerdings (1977) state that sainfoin and crested wheatgrass are not recommended on Grey Wooded soils, while sweet clover and creeping red fescue are the most easily established. They also state that for soils with poor drainage, bird-foot trefoil, reed canary grass, timothy, and meadow foxtail are the best adapted, whereas red clover, birds-foot trefoil, alsike and reed canary grass are best adapted on acidic soils.

The types of cereal or oilseed crop grown in rotation on Grey Wooded soil depends on the local climate and the characteristics of the individual soil. For example, in a given area, the crop must be able to mature and to withstand any adverse condition of the soil such as acidity. Oats grow well on acid soils while wheat and barley do not. Barley and oats are major crops on these soils while wheat is grown in only a few areas. Rapeseed grows well on Grey Wooded soil perhaps due to the favorable moisture supply. However, a lot of attention has to be given to proper fertilizer application. Flaxseed production has also been quite successful on these soils (Bentley et al. 1971).

TABLE 29

RECOMMENDED MIXTURES FOR THE GREY WOODED SOIL ZONE

Brome and Alfalfa
Intermediate Wheatgrass and Alfalfa
Creeping Red Fescue and Brome and Alfalfa
Creeping Red Fescue and Intermediate Wheatgrass and Alfalfa
Reed Canary Grass and Alsike (Flooded)
Timothy and Alsike (Flooded)
Alfalfa
Sweetclover
Alsike Clover
Red Clover
Birdsfoot TreFoil

SOURCE: Mitchell, Gordon and Allerdings, Erwin (1977). Reseeding and grazing system for the Parkland and boreal Forest Regions. Range Improvement in Alberta: A literature review. A project of the Plant Science 515 class. University of Alberta.

As mentioned, one of the problems of Grey Wooded soils is mineral deficiencies. Organic matter is the main source of nitrogen in most soils and of sulfur in many soils; therefore, low organic matter in Grey Wooded soils results in low levels of nitrogen and sulfur. Phosphorus deficiencies occur on many Grey Wooded soils while potassium, manganese and boron deficiency occur occasionally (Bentley et al. 1971). Robertson (1979) states that potassium deficiencies will likely become much more common as soils are cropped longer and as the levels of other nutrients are increased by fertilization.

As a result of the many mineral deficiencies, fertilization of forages, oilseeds and cereals is needed to ensure adequate yields per acre. Bentley et al. (1971) state that suitable fertilization often more than doubles the yield where nitrogen and/or sulfur are deficient. Sulfur fertilizers are required for legumes, and phosphorus fertilizers are also required in many cases. If legumes are properly innoculated with N-fixing bacteria, nitrogen fertilizers are not required. Grasses, cereals and oilseeds not only require sulfur and in many cases phosphorus fertilizers, they also require nitrogen fertilizers as well (Bentley et al. 1971, Robertson 1979). Robertson (1979) states that whenever regular applications of phosphorus containing fertilizers have been applied, the phosphorus status of the soil has probably improved. Therefore, omission of a phosphorus application in any one year is less likely to be detrimental than omission of sulfur and nitrogen fertilizers. Proper fertilization of all crops is essential for good yields. As fertilizer requirements vary from area to area, carefully taken samples of soil should be submitted for testing (Bentley et al. 1971).

In addition to fertilization, Bentley et al. (1971) recommend application of manure and working crop residues into the soil to add organic matter. They contend that manure is an excellent fertilizer and improves the physical properties of the soil.

The results of a study carried out in various Peace River locations dealing with the effects on barley of different combinations of fertilizers, including manure, are presented in Figure 8.

Fertilization, including manure, along with a legume containing forage-grain rotation not only substantially increases yields, but also improves the nutritive quality of crops (Bentley et al. 1971). Bentley et al. (1971) cite many results from nutritive studies completed:

- One study showed that wheat grown after legumes had a higher protein content than wheat grown after the fallow. The authors explained that the inoculated legumes not only produced nitrogen when growing, but when plowed, the crop residues decayed slowly throughout the growing season releasing nitrogen to the grain crop. The third wheat crop had less protein compared to the first two due to smaller amounts of decomposing legume residues.

- A rat feeding trial showed the same results and in addition, it showed that after legumes, grains receiving recommended fertilizers were nutritionally superior to grains not receiving fertilizer.

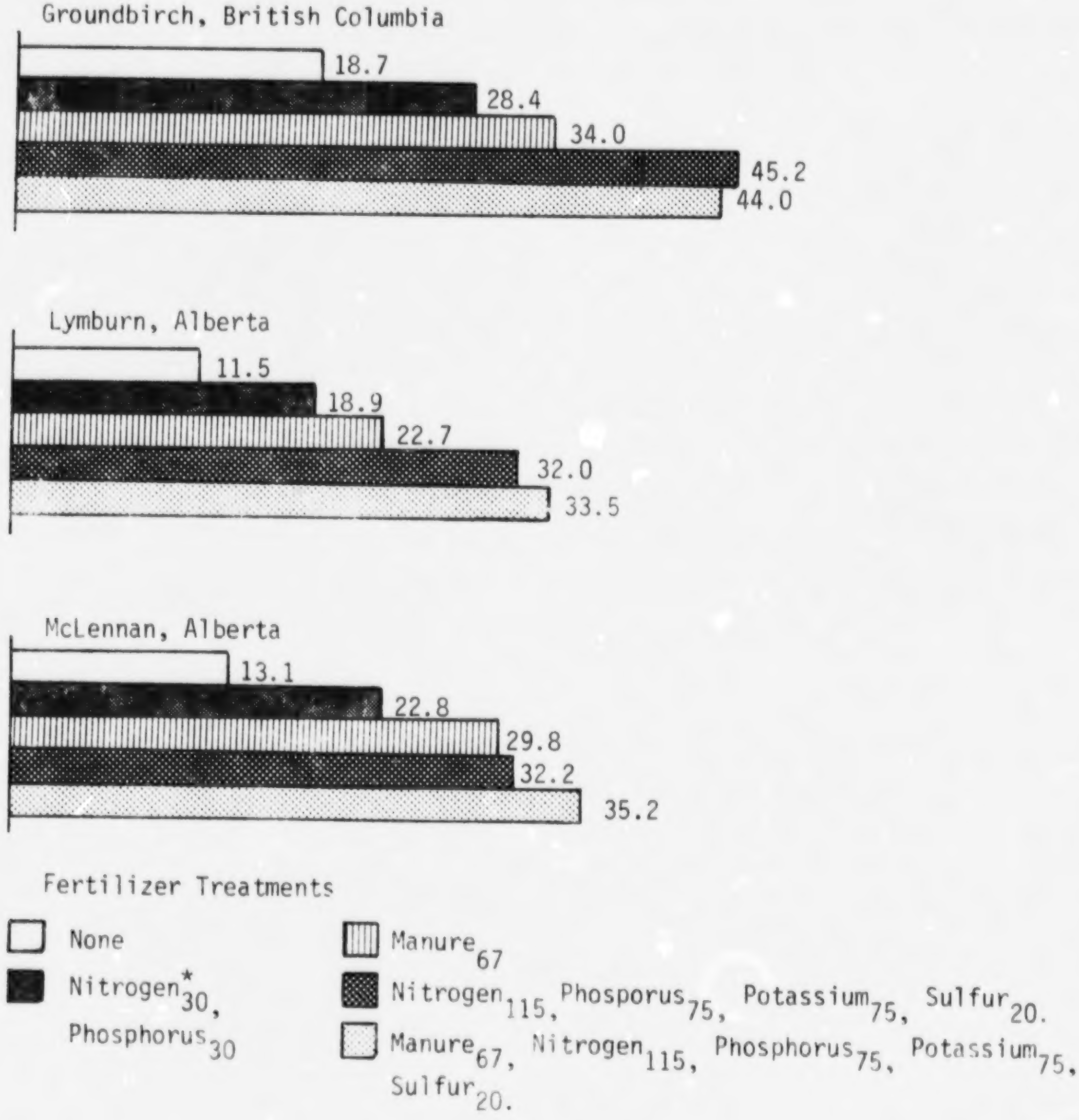
- Baking quality results showed that fertilization treatments of wheat grown after legumes caused actual changes in the quality of the wheat protein.

- A study done on sulfur deficient soils showed that sulfur fertilization increased the protein content of alfalfa, altaswede, alsike, and sweet clover. Similarly, rabbit feeding studies showed that the feed value of hay increased substantially after recommended fertilizers were applied.

- Other results showed that sulfur fertilized legumes improved the nutritional quality of subsequent wheat crops.

FIGURE 8

FIVE YEAR AVERAGE YIELDS OF GALT BARLEY, VARIOUSLY FERTILIZED, AT PEACE RIVER LOCATIONS (1966-1970, c.w.t./acre)



* Rate of application - pounds per acre.

Source - Bentley, C.F., Peters, T.W., Hennig, A.M.F., and Walker, D.R. (1971). Grey Wooded Soils and their Management. Bulletin B-71-1, University of Alberta, Canada Department of Agriculture.

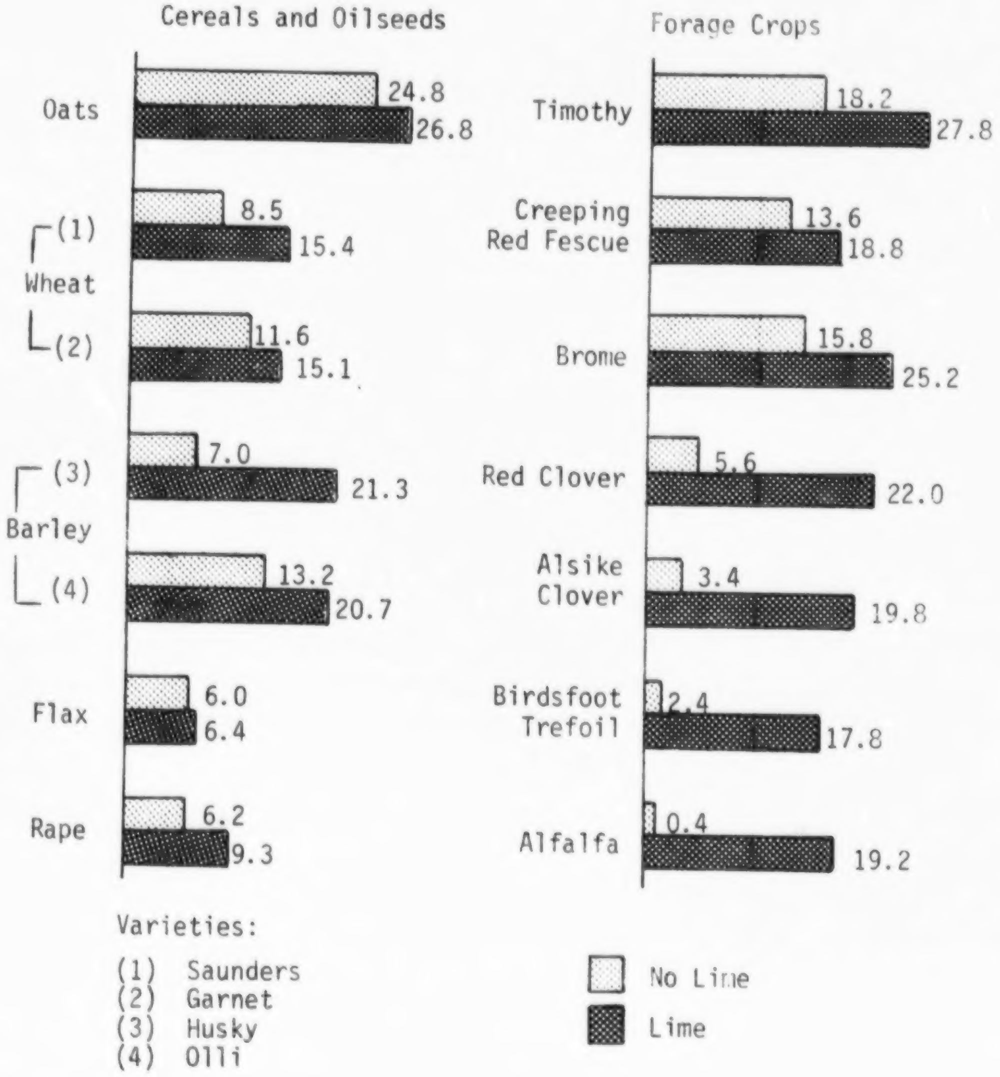
One problem mentioned that is common to Grey Wooded soils is soil acidity. Bentley et al. (1971) state that the major cause of soil acidity damage to all crops is the high solubility of soil manganese and aluminum. Both of these elements are harmful to crops when excessive amounts are present in soluble forms. Also, acid soils may reduce the ability of legumes to fix nitrogen, and phosphorus and molybdenum tend to be less available to plants. In comparison, Nyborg (1972) states that the main effect of soil acidity on legumes is the inhibition of the nitrogen fixing bacteria. In a study by Webster and McCoy (1974), they showed that increased acidity depressed growth, nodulation,and nitrogen content of alfalfa.

All crops vary greatly in their tolerance to soil acidity with oats being very tolerant and alfalfa being one of the most sensitive (Bentley et al. 1981, Agriculture Canada, 1974). Agriculture Canada (1974) and Nyborg (1972) state that there are two ways to handle acid soils. One way is to grow crops that tolerate acid soils, another way is to lime the soil to correct the acidity so that acid-sensitive crops can be grown. Bentley et al. (1971) agree with liming soils. They feel that it is the only practical way to correct acidity. Common liming materials include calcium carbonate and calcium-magnesium carbonate. Other materials used include hydrate lime, marl, pulpmill by-products, and industrial slag (Bentley et al. 1971, Agriculture Canada, 1974).

Figure 9 shows how very acid conditions affect the different crops and how liming is very effective for increasing yields of acid-sensitive crops. The results show that oats, flax and grasses are the most suitable crops for extremely acid soils. In fact, oats grow fairly well even when soils are pH 5.0 or less. Other results show that trefoil, red clover and alsike may be grown successfully on some soils that are too acid for alfalfa (Bentley et al. 1971). Nyborg's (1972)

FIGURE 9

YIELDS OF CROPS GROWN ON TWO VERY ACID SOILS, WITH AND WITHOUT LIME. (2 Year Average, c.w.t./acre)



Source - Bentley, C.F., Peters, T.W., Hennig, A.M.F., and Walker, D.R. (1971) Grey Wooded Soils and Their Management. Bulletin B-71-1, University of Alberta, Canada Department of Agriculture.

results showed that liming increased yields of alfalfa on soils of pH 6.0 or less, and as acidity increased the yield increases from liming were generally greater. He also showed that red clover yields seldom increased significantly by liming unless soil pH was 5.5 or less.

Agriculture Canada (1974) contends that an application of lime lasts at least 7 years; however, under the soil and climatic conditions in Alberta, the application will probably last 10 years or more. Alberta's rainfall is comparatively low and soils generally fine textured, discouraging the downward movement of lime. They also state that subsequent applications of lime to restore the soil to the desired pH level will be substantially less than the initial application.

Acid soils are the result of organic acids, produced by decomposing leaves and needles, severely leaching alkaline elements downward, continued use of fertilizers, and soil formation on acid parent material (Bentley et al. 1971). In two studies done by Webster and McCoy (1974, and 1977), it was shown that small amounts of nitrogen and sulfur fertilizer applied over a long period of time resulted in an increase in soil acidity sufficient to reduce the growth of alfalfa. Nyborg (1972) states that application of 40 pounds of ammonium nitrogen annually for 5 to 10 years would lower the pH of many soils by 0.5 units. As a result, soils having a pH in the range of 6.1 to 6.5 may eventually become sufficiently acidic to affect crop yields. Webster and McCoy (1974, and 1977) also found that manure applications are not as acid forming as commercial fertilizers and that manure applied with commercial fertilizers helped reduce the degree of acidification. This shows that manure serves as an effective buffer against soil acidification. With increased fertilization in recent years, it is likely that soil acidification will increase, especially on Grey Wooded soils which are naturally more acidic than other soils. Reduced use of fertilizers will result in reduced yields. Since reducing fertilizer use is impractical, it is likely that there will be increased use of lime and perhaps greater use of acid-tolerant crops.

Due to Grey Wooded soils having poor tilth, friable seedbed preparation for forages, cereals, and oilseeds is difficult. Cultivation should be done when the soil is moist providing the seedbed with a cloddy structure. Finer textured soils tend to powder if cultivated when too dry and to puddle or form a compact mass if cultivated when wet. A cloddy structure does not readily puddle or crust after heavy rains followed by drying, whereas a powdery seedbed is prone to crusting. A cloddy structure also does not dry out as quickly as a very lumpy seedbed. Excessive cultivation should be avoided as it will dry out the surface layer - best yields are obtained with just enough cultivation to kill the weeds. In the case of forages, if the weed problem is not too bad, seeding may be done directly into the stubble land with no prior cultivation. Deep cultivation is also not necessary (Bentley et al. 1971).

Seeding of forages should occur in late fall (near freeze up) or early spring to ensure good stands. The seed should be placed at a shallow depth in the soil ensuring better and more uniform emergence than if the seed is broadcast, especially if surface moisture is limited. Forage crops should also be seeded by themselves. Companion crops compete with the developing forage and reduce forage yields even in the third year hay crop. It is also important that all legumes be innoculated just before seeding even if they will be seeded in an area that had recently grown innoculated legumes. Modified grain drills are satisfactory for seeding forages. The various commercial seeders have the disadvantage of pulverizing the soil excessively and increasing the possibility of severe soil crusting. Maximum depth for seeding cereal and oilseed crops should be similar to or slightly less than that on soils of higher organic matter. If the soil is particularly prone to crusting, yields may be improved if seeding rates are higher. The higher rates help to break the crust and promote effective seedling emergence (Bentley et al. 1971).

Harvesting crops on Grey Wooded soils presents no additional problems to those encountered on other soil types (Bentley et al. 1971).

Management Practices - Pasture

From the discussion on rotational crops, it is clear that many management practices for forages in rotation will apply to forages in pasture. For example, seedbed preparation, seeding, and recommended forage mixture are the same for forage in rotation and in pasture (Mitchell and Allerdings 1977). Mitchell and Allerdings (1977) cited studies showing the increased production and protein content of grass-legume pastures vs. grass pastures. They also showed results of native pastures vs. tame pastures with tame pastures yielding significantly more than native pastures. In early June, tame pastures were producing 1,800 to 2,000 kg/ha compared to 300 to 500 kg/ha for native pastures. At maturity, tame pastures had a three to four fold increase over native. Fertilization is similar. Nester (1977) recommends sulfur and phosphorus fertilizer as well as nitrogen fertilizer. However, nitrogen fertilizer applied to a legume-grass mixture may give an advantage to the grass eliminating legumes from the stand and sulfur applications may increase problems with low selenium levels in the forage. Advantages to fertilizing are: increased forage production, increased quality of the forage, increased carrying capacity and animal gains, increased length of the grazing period and improved palatability of generally unpalatable species (Nester 1977). All pastures, no matter what type of soil they are on, need a respectable grazing system. Mitchell and Allerdings (1977) cited a study done on tame pastures using continuous and rotational grazing systems. The per acre animal gains on the rotational system were more than 50 pounds higher than on the continuously grazed pasture. It was found that in the continuous grazing system, alfalfa declined due to it being selectively grazed resulting in decreased animal gains. Whereas in the rotational grazing system, alfalfa remained in the stand with greater vigor.

Conclusion

The many problems encountered on Grey Wooded soils make farming more difficult and hazardous than farming on most of the other Alberta soils. As a result, Grey Wooded soils used for either rotational crops or pasture require intensive management practices in order to obtain yields comparable to yields on other soils. The combination of legumes, fertilizers, lime, seedbed preparation and seeding substantially increase yields and improve the nutritive quality of the crops. Prior to these management practices, proper clearing and breaking techniques must be used. The clearing methods used depend on the tree cover; the breaking method used not only depends on the method of clearing used but also on the soil type; therefore, some breaking methods should be avoided in the Grey Wooded soils. The extent of breaking and subsequently working is extensive in order to prepare a satisfactory initial seedbed for rotational crops. With regards to initial seedbeds for pastures, this issue is still being debated among researchers.

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